HYSICS EXHIBITION REPORT

MAY 195
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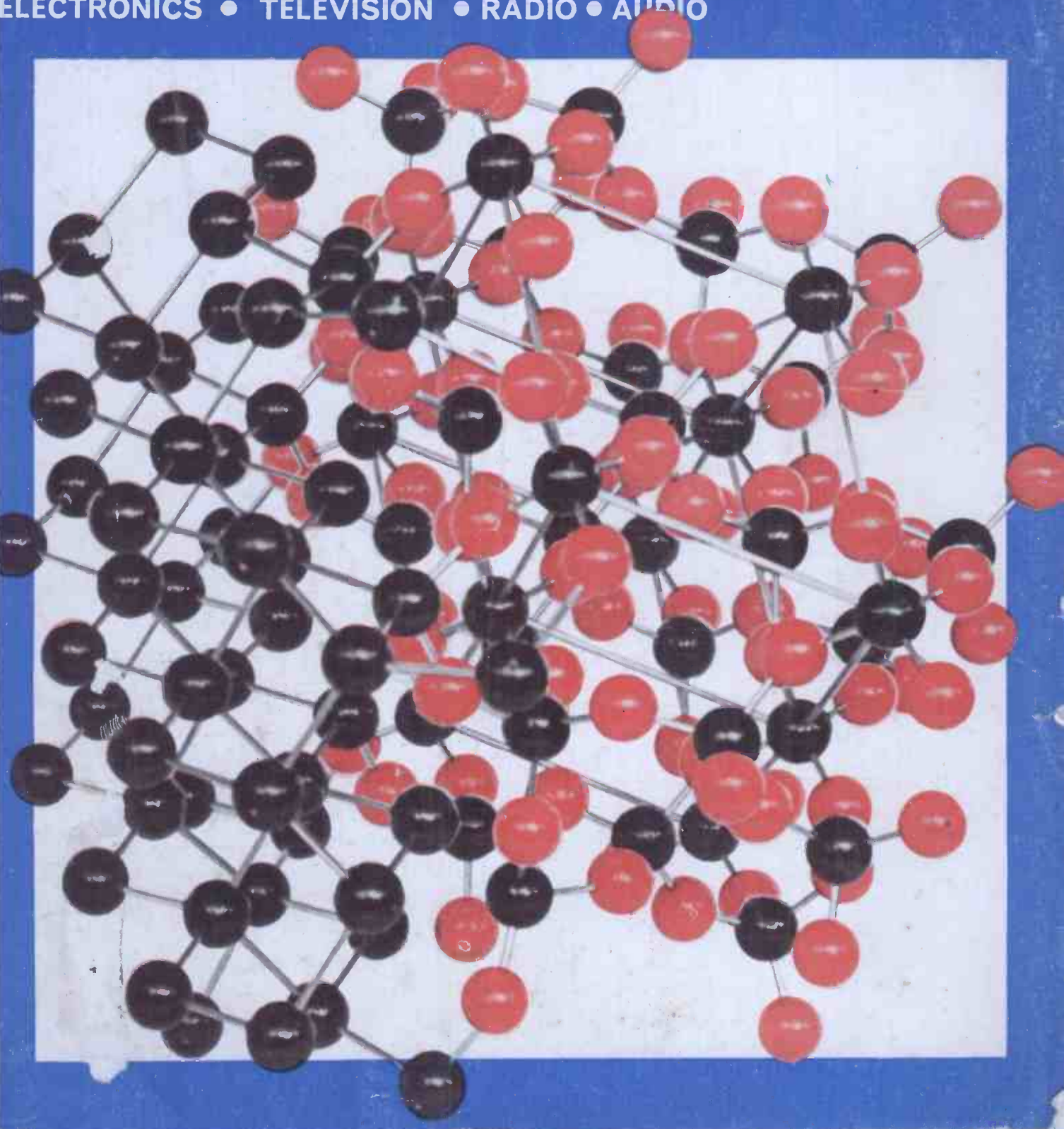
Wireless World

ELECTRONICS • TELEVISION • RADIO • AUDIO



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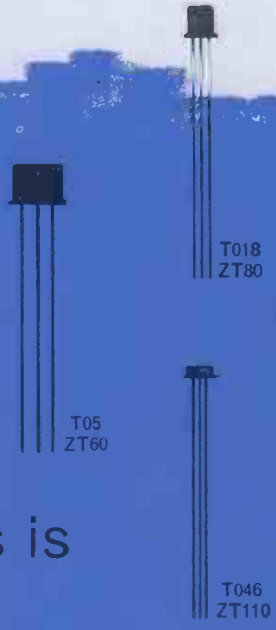

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Rating or Characteristic	Symbol	ZT60 ZT80 ZT110	ZT61 ZT81 ZT111	ZT62 ZT82 ZT112	ZT63 ZT83** ZT113	ZT64 ZT84** ZT114	ZT66 ZT86** ZT116	ZT67 ZT87 ZT117	ZT88 ZT118	ZT89 ZT119	Test Conditions
Collector Base Voltage	V_{CBO}	25	45	45	60	60	100	25	100	70 volts	$I_E = 0$
Collector Emitter Sustaining Voltage	$V_{CEO(Sus)}$	25	35	35	45	45	80	25	80	70 volts	$I_B = 0$ $I_C = 5mA$
Emitter Base Voltage	V_{EBO}	4	4	4	5	5	5	4	5	5 volts	$I_C = 0$
Collector Peak Current	I_{Cpk}	500	500	500	500	500	500	500	500	500 mA	
DC Collector Current Gain	h_{FE}	38-162	38-162	78-250	35-85	75-170	35-85	78-250	75-170	50-200	$I_C = 10mA$ $V_{CE} = 6V$
Collector Base Reverse Current	I_{CBO}	0·5	0·5	0·5	0·05	0·05	0·05	0·5	0·05	0·5μA	$V_{CB} = V_{CBO}$ $T_{AMB} = 25°C$
Collector Saturation Voltage	$V_{CE(Sat)}$	0·4	0·4	0·4	0·4	0·4	0·4	0·4	0·4	0·4 volts	$I_C = 50mA$ $I_B = 5mA$ $I_C = 10mA$ $I_B = 2mA$
AC Current Gain (typical)	h_{fe}	10	10	10	10	10	10	10	10	10	$f = 20Mc/s$ $I_C = 10mA$
Power Dissipation	P_{tot}	300	300	300	300	300	300	300	300	300mW	NB. P_{tot} for ZT60-ZT66 = 350mW
Minimum Burn-In Period	t_{BPmin}	48	48	48	48	48	48	48	48	48 hrs	$P_{tot} = 150mW$ $T_{AMB} = 100°C$

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Wireless World

ELECTRONICS, TELEVISION, RADIO, AUDIO

MAY 1965

209 Editorial Comment
210 A Single-Carrier Colour Television System — *By E. J. Gargini*
213 Duality — *By "Cathode Ray"*
217 Books Received
218 I.F. Sweep Generator — *By M. W. Rignall*
220 Cathode Emitter and Decoupling — *By J. F. Young*
223 Manufacturers' Products
229 World of Wireless
231 Personalities
233 News from Industry
235 50 Years of Public Address
237 Physics Exhibition in the North
243 Paris Components Show
245 Colloquium on Memory Techniques
246 Letters to the Editor
249 Satellite Communications Service Begins
251 Electronic Laboratory Instrument Practice—5 — *By T. D. Towers*
256 This Month's Conferences and Exhibitions
257 May Meetings
258 Logic Circuits
258 H.F. Predictions—May

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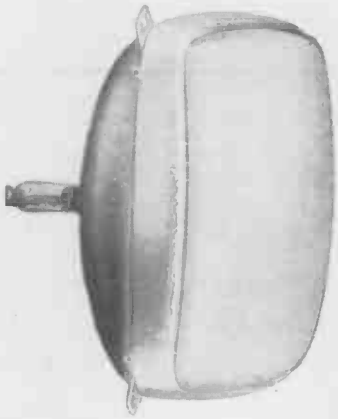

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ELECTRONICS, TELEVISION, RADIO, AUDIO

Science and/or Engineering

OUR front cover this month is symbolic of the complex physical structures which lie at the foundation of modern solid-state electronics. It is intended to show the importance of science, as exemplified in the report elsewhere in the issue on the Physics Exhibition, in breaking new ground for development by the technologist and utilization by the engineer.

Practising scientists and engineers respect each other as compeers exercising the same intellectual powers to different ends, but aspirants to these professions, and in particular young sixth formers deciding upon a career, seem to be attracted more by the glamour of science and less by the prospects of engineering, which many regard as a dull pedestrian pursuit.

What are the essential differences between science and engineering? A quick answer would be that science is easy and carefree whereas engineering is difficult and loaded with responsibility. No stigma attaches to the scientist whose hypothesis is proved false by experiment; only the return of "don't know" as the conclusion from his work can be scored as a failure. Engineering, on the other hand, can never contemplate so negative a termination, though the possibility of failure must always be present as a spur. Success is approached on a broader front. Engineering is a skill and, as R. Hadekel has pointed out recently (*The Chartered Mechanical Engineer*, March 1965, p. 176) it has its roots in craftsmanship. As such it pre-dates science not by centuries but by aeons. The modern scientific method (hypothesis tested by observation and experiment) has been establishd as a discipline for less than 400 years.

To claim that engineering is applied science is to do it less than justice. Applied science may produce a new technique, even a whole technology, but these wait upon the needs of the engineer and are his tools.

What is the superior attraction of science over engineering for the school-leavers of today? Could it be that science combines the freedom of dilettantism with the chance of making a great discovery, whereas engineering calls for iron discipline and steady application to a limited end? If so there are several ways of redressing the balance. One which we rather like was suggested recently at the Annual Dinner of the I.E.E. by its president, Mr. O. W. Humphreys, namely, that young men should be allowed first to sow their wild oats in pure research before moving on in maturity to engineering.

Engineering talent is born, but may remain dormant unless it is fostered by precept and fired by enthusiasm. The difficulty is that there are not enough good engineers to supply the needs of both industry and education. Suggestions that there should be part-time exchanges between these professions have frequently been made, but have not proved practicable. At a recent conference of headmasters in Cambridge, organized by the Engineering Institutions Joint Council and the Royal Society to discuss means of increasing the numbers of aspirants to an engineering career, it was generally agreed that a firm grounding in physics and mathematics *must* be given priority. Sir Willis Jackson expressed himself as against the teaching of engineering in schools but in favour of the use of imaginative experiments and films to show the *relevance* of physics and mathematics to engineering. There should then follow a year in industry before entry to a university where a first-year course common to *both* science and engineering students would be undertaken.

This seems the best way of settling the matter, for by the time the student has reached his second year at university and the real work is about to begin, any early romantic fantasies will have given place to an appreciation of the deeper satisfaction which a career in one or other of these disciplines will give.

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A SINGLE-CARRIER COLOUR TELEVISION SYSTEM

By E. J. GARGINI*

A STUDY of the possibilities of h.f. wired television distribution has led to the formulation of a new type of colour transmission system[1] which could prove to have considerable advantages if used for colour television broadcasting. In this proposed compatible system, called SEQUIN (Sequential Quadrature Inband System), the colour information is transmitted sequentially by a suppressed carrier signal at the same frequency as the main carrier but in quadrature phase relationship with it. Brightness information is transmitted in the ordinary manner, the main carrier being modulated in the negative sense. The complete signal provides the monochrome picture for existing (625-line) black-and-white receivers.

The colour signal conveys two sets of colour information in sequence. These two sets can be either two colour-difference signals, of the form E_R-E_Y and E_B-E_Y, or two colour-ratio signals, of the form $(E_R/E_e)-1$ and $(E_B/E_e)-1$, where E_e is an equal-energy brightness signal formed from equal proportions of the three camera tube outputs. The first kind of signal, providing chrominance information, permits simple matrixing techniques in receivers but has the disadvantage, common to all chrominance systems, that fine detail brightness information is displayed as fine detail whiteness information[2] on both colour and monochrome receivers. The second kind of signal, conveying chromaticity information, overcomes this defect and permits approximate constant chromaticity and exact constant-luminance operation of the colour receiver[3], with separate luminance signals. Normally the two sets of colour information would be transmitted line sequentially, but theoretically dot-sequential or frame-sequential working would also be possible.

The complete transmitted signal can be considered as a carrier wave modulated both in amplitude and phase. This is shown vectorially, for the chrominance system, in Fig. 1, where the modulus (envelope amplitude) and angle (carrier phase) of the rotating vector are determined by the amplitudes of the luminance signal and of a colour-difference signal in quadrature. Mathematically the vector modulus is given by

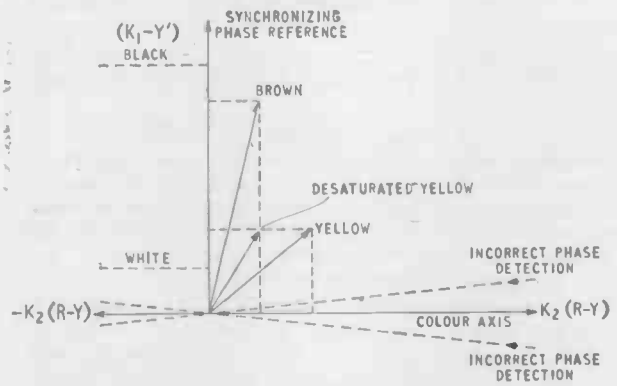
$$|E_{vision}| = [(K_1-E'_Y)^2+K_2(E_{R-Y} \text{ or } K_3E_{B-Y})^2]^{\frac{1}{2}}$$

where $|E_{vision}|$ is the instantaneous carrier amplitude, E'_Y is the amplitude of the luminance component, and K_1, K_2 and K_3 are constants. The carrier wave phase angle is given by:

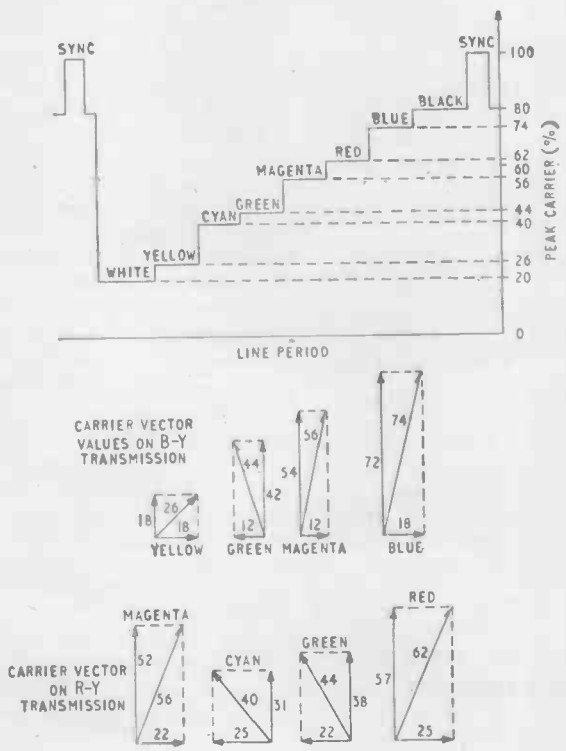
$$\angle E_{vision} = \tan^{-1}\left[\frac{K_2(E_{R-Y} \text{ or } K_3E_{B-Y})}{K_1-E'_Y}\right]$$

where $\angle E_{vision}$ is the instantaneous phase angle of the carrier in degrees, and K_1, K_2 and K_3 are constants as

*Rediffusion Research Ltd.

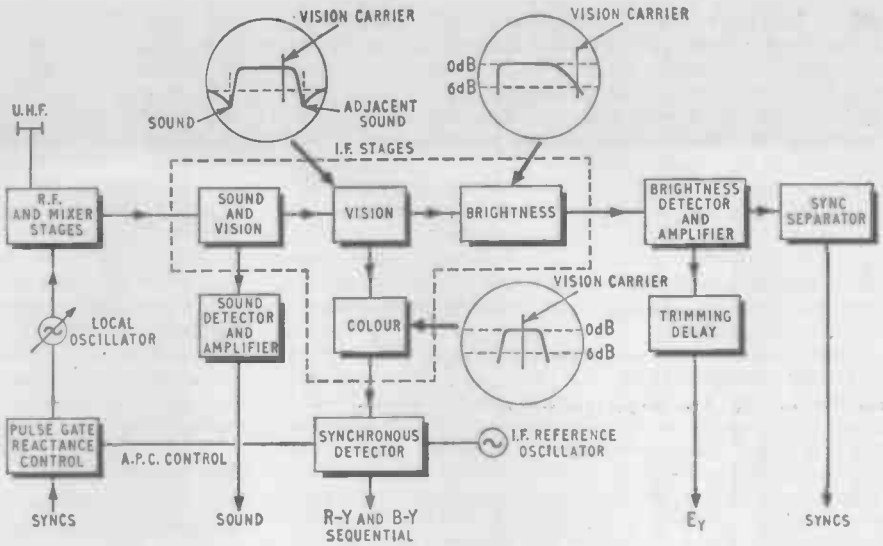


Above:—Fig. 1. Vectorial representation of the complete SEQUIN signal (for the chrominance system). Correct phase detection, $(R-Y) + Y=R$, etc.; incorrect phase detection, $[R-Y \pm \triangle (K_1-Y')] + Y=R\pm\triangle(K_1-Y')$ etc.

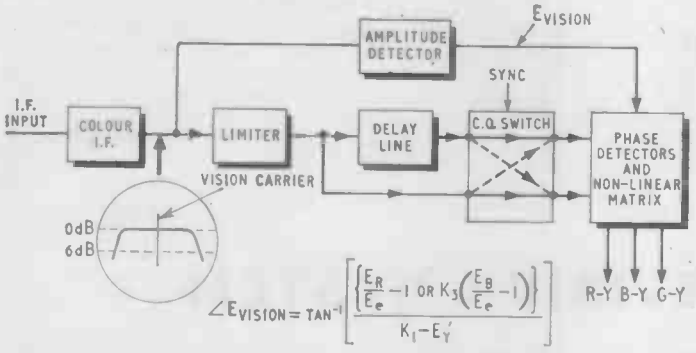


Right:—Fig. 2. Modulating amplitudes and carrier phase angles for a colour-bar transmission on SEQUIN (for R−Y, B−Y version). Maximum values correspond to condition: $E_{B-Y} = E_{vision}$ on yellow, and $E_{R-Y} = 1.8E_{B-Y}$.

Right:—Fig. 3. Receiver schematic, assuming that chrominance information is transmitted.



Below:—Fig. 4. Alternative detection system for receiver, assuming chromaticity information is transmitted.



above. Fig. 2 shows modulating amplitudes and carrier wave phase angles for a colour-bar transmission.

Recovery of the two sets of sequential colour information at the receiver requires a colour synchronizing signal. This is, in fact, transmitted automatically by the system, since, with negative modulation, the line and frame sync pulses constitute large-amplitude, long-duration bursts of carrier frequency in exact phase quadrature with the wanted colour signal. (During these bursts the colour signal is not transmitted and so does not affect the carrier phase.)

In the receiver two types of colour-signal detection are envisaged. The first of these, which assumes that chrominance information is transmitted, line sequentially, uses a single synchronous detector (see Fig. 3). The detection process includes an automatic frequency control system in which the local oscillator frequency is continuously adjusted to maintain the standard i.f. vision carrier in a fixed frequency and phase relationship to a second local oscillator, operating at this same frequency or at a sub-multiple frequency. This second oscillator provides the carrier re-insertion signal for synchronous detection of the sequential E_R-E_Y and E_B-E_Y components of the colour signal. Any departure from the correct phase setting of the synchronous-detector oscillator introduces positive or negative sync pulses into the colour channel and these can be used to maintain the phase angle of the re-inserted carrier at its optimum value. This carrier locking technique used in this type of receiver introduces some complication but it is the author's view that frequency control of u.h.f. colour receivers is desirable with any colour system.

In the second type of colour receiver, which assumes that chromaticity information is transmitted (Fig. 4), conventional frequency changing techniques with less precise frequency control may be possible. The colour signal could possibly be recovered by applying the composite vision carrier signal to a limiter and ratio type phase detector, the output of which would be further processed in a non-linear matrix to obtain colour-ratio or wide bandwidth colour difference signals. Either type of receiver could be arranged to suit chromaticity or chrominance information transmission.

The delay line required in either type of receiver could be a steel wire type, and in the second type of receiver could be operated by the phase modulated signal available at the output of the phase limiter.

A SEQUIN transmission received on conventional black-and-white receivers should not show any degradation of picture quality from that obtainable with monochrome transmissions. On colour receivers the brightness resolution should equal that obtainable on monochrome.

In conventional quadrature transmission systems the two simultaneous signals are recovered by a carrier re-insertion process along the wanted signal axis. When the upper and lower sideband structure is substantially uniform these signals may be recovered independently, that is, free from transient crosstalk. In the SEQUIN proposal medium-detail colour information and brightness information is transmitted double sideband over the normal double-sideband region of the transmission standard, and over this region a colour signal may be recovered which is free of brightness information. The remaining fine-detail brightness components would be transmitted as in normal monochrome practice over the single-sideband region, and as this band of frequencies conveys no colour information the brightness components would be recovered free of colour information.

Because in SEQUIN the monochrome carrier is not suppressed, no carrier re-insertion is necessary along the brightness axis. This feature allows compatible operation of conventional monochrome receivers and also permits a

simple brightness-signal detection process in colour receivers, provided two precautions are taken before transmission. Simple diode detectors respond to the modulus of the composite transmitted waveform, which yields an incorrect grey scale. Thus brightness-signal compensation must be introduced to ensure that the modulus of the transmitted waveform is, in fact, the desired brightness signal. The second precaution is the generation of a pre-correcting signal to compensate for vestigial reception of the brightness signal. The main carrier is received at a nominal —6dB point in the receiver response, and without this correction the colour signal sidebands would introduce some brightness-signal transient distortion.

Simple tests have indicated that there is no difficulty in effectively compensating for the receiver modulus distortion at the transmitter, and a theoretical study and simple tests have indicated that because colour transients are less rapid than brightness transients, low order spurious signal generation at receivers may be effectively cancelled by transmitter compensation, although this is a more difficult process. The carrier locking technique mentioned in connection with the chrominance type of receiver is currently in use in wired distribution signal originating equipment for translating from a v.h.f. carrier to an h.f. carrier.

An important advantage of the proposed SEQUIN system is that it would make possible simpler receiver tuning—which, in subcarrier systems, can be a somewhat critical factor in obtaining good colour reproduction. In a SEQUIN receiver (of the first type) the local oscillator would always be locked in the correct frequency and phase relationship to the carrier, and colour reproduction would not depend on correct placing of a sub-carrier on the receiver response curve.

In general the proposed system has the advantages of a sequential system but would also overcome the compatibility problem that has characterized SECAM. Horizontal colour resolution would be superior to that of other systems because of the wider bandwidth colour signal (1.5 Mc/s for the British 625-line standard); and signal/noise ratio would be better, because of the different manner in which the transmitter power is shared between the brightness and colour signal. Low-power v.h.f. or u.h.f. translater stations would be able to handle the SEQUIN signal (which has no video equivalent) by the standard frequency changing technique without recourse to further transcoding. Finally, selective fading would not affect the ratio of brightness information and colour information.

Acknowledgment

The author expresses his thanks to the Directors of Rediffusion Research Ltd. for permission to publish this article.

REFERENCES

1. British Patent Application 17346/64. See also "Colour television by wire," a paper read to the Television Society on 18th September, 1964.
2. "An alternative colour TV system," by E. J. Gargini. *Wireless World*, August, 1957.
3. See "Constant luminance," by Ian MacWhirter. *Wireless World*, November, 1964.

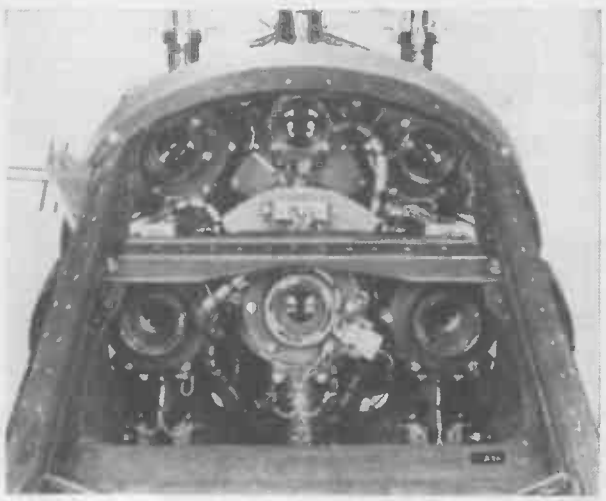
RANGER TELEVISION SYSTEM

The 3W transmitter-receiver (for commands, telemetry, etc.) in the Ranger "bus" or platform was powered by two solar cell panels.

AFTER transmitting more than 5,800 pictures of the lunar surface Ranger 9, the final in the series, impacted the moon in the Crater Alphonsus on March 24th. Similar successful flights were achieved with Rangers 7 and 8 giving altogether a total of some 16,000 pictures taken at distances varying from 1,500 miles to $\frac{1}{4}$ of a mile from the moon. The resolution of the pictures televised by the six-camera R.C.A. system was excellent, detail being clearly observed in the final pictures of craters estimated to be about a yard across.

The television system, which was powered by two 33V batteries, employed two full-scan and four partial-scan cameras. The full-scan 1,125-line cameras were exposed and read out sequentially at 2.5 second intervals and the partial-scan cameras, which utilized only the central 282-lines of the raster, at 0.2 second intervals. During the intervals between exposure the photoconductive surface of each 1-inch vidicon tube was erased. Two 60W transmitters were employed for the TV system operating on 959.52 and 960.58 Mc/s.

Six R.C.A. cameras (the full-scan are in the centre) pointed at an angle of 38° from the roll axis of the spacecraft.



DUALITY

By "CATHODE RAY"

I DON'T usually have much to say in *Wireless World* about the Government, and the Editor is probably reaching for his blue pencil (or the electronic destructor that has no doubt superseded it) at the mere suggestion of such a thing, but he can relax. All I am going to remark on, and that quite non-politically, is the creation of Ministries of Education and Science and of Technology; because this is a sign of how growingly important these subjects are, and the need for more and better instruction therein. Every year the distance that students have to go through basic matters in order to reach the working face of their subject is greater. So anything that can help speed their effective progress is worth utilizing.

Perceptive teachers would agree, I think, that things are more easily remembered and more clearly understood if a pattern of relationships is seen. One of the admittedly most helpful methods of approaching a new subject is by way of analogy. And so electric currents in wires are likened to water flowing through pipes, difference of potential to difference in height above sea level, and so on. The danger of analogies such as this is that they are not perfect, so if they are followed too far they can mislead. For instance, resistance to the flow of water in a pipe is not inversely proportional to its cross-sectional area, as is resistance to the flow of electric currents in wires.

Duality is a perfect analogy. So it deserves special attention. Readers who have persisted with me for long—I believe there are some—may have noticed my occasional bursts of salesmanship for duality. But there are always others for whom this is their first *Wireless World*, and presumably still more whose ideas (if any) about electrical duals and duality are vague. It is these I invite to gather around.

The most elementary instruction on electric circuits includes the two modes of connection—series and parallel. When we come to a.c. we are told that inductance and capacitance behave in some respects as opposites. Both of these dual concepts occur together in resonant circuits, which contain inductance and capacitance and come in two kinds—series and parallel. If we compare the equations relating to them we should find certain systematic resemblances. To come to the point, all true statements or equations connecting the things in either of the columns below can be transformed into other true statements or equations by substituting the corresponding words or symbols in the other column.

Current, I	Voltage, V or E
Voltage, V or E	Current, I
Resistance, R	Conductance, G
Conductance, G	Resistance, R
Inductance, L	Capacitance, C
Capacitance, C	Inductance, L
Reactance, X	Susceptance, B
Susceptance, B	Reactance, X
Impedance, Z	Admittance, Y
Admittance, Y	Impedance, Z
Series	Parallel
Parallel	Series
Mesh	Junction (or node)
Junction (or node)	Mesh
Short-circuit	Open-circuit
Open-circuit	Short-circuit

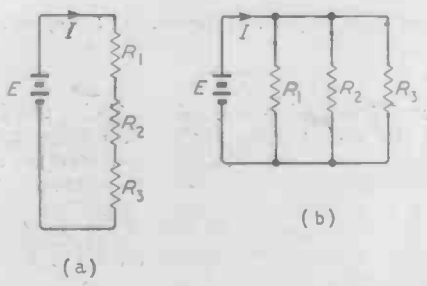


Fig. 1. Although "Ohm's law" is easy to apply to (a) it is slightly less convenient for (b), and its dual is to be preferred.

Each item in these lists is the dual of the other on the same line. We can take a general equation connecting any of the listed quantities, and construct its dual by substituting the dual quantities. Take the familiar example usually called Ohm's law:

$$E = I\,R \quad .. \quad .. \quad .. \quad .. \quad (1)$$

Substitute the symbols in the opposite column and we get

$$I = E\,G \quad .. \quad .. \quad .. \quad .. \quad (2)$$

which is also true and sometimes more useful, especially with parallel circuits. Equation (1) is quite suitable for attacking Fig. 1(a), because the total R is just the sum of all the resistances, so the particularized version of (1) is

$$E = I(R_1 + R_2 + R_3) \quad .. \quad .. \quad .. \quad (3)$$

But the first time we are confronted with Fig. 1(b) we have to think a bit and finally come up with

$$E = \frac{I}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}} \quad .. \quad .. \quad .. \quad (4)$$

which lacks elegance. By applying duality to (3)—i.e., by referring to our parallel columns—we are spared the need for any thought and we arrive directly at the same thing as (4) in the neater form

$$I = E(G_1 + G_2 + G_3)$$

Conductance, G, is of course the reciprocal of resistance, i.e. $1/R$. It is also the dual of resistance, but not all dual quantities are reciprocals; the dual of L is not $1/L$.

As well as dual quantities and dual equations there are such things as dual circuits. You might think that Fig. 1(b) was the dual of (a) because its equation is. But we can see that this is not exactly so if we describe (a) in words and then transform it by using the parallel lists: thus, (a) comprises three resistors all in series with a voltage source. So its dual must be three conductors all in parallel with a current source.

A little difficulty arises when we come to draw the dual circuit diagram. Voltage sources are quite familiar: batteries and d.c. generators for d.c., and a.c. generators for a.c. Ideally they should have no resistance or impedance in themselves, and this condition can be approximated fairly closely in practice. Its dual must be a current source with no conductance in itself, and such things are not practical. The best we can do is use a very

high voltage source in series with a very high resistance. There isn't even a reasonable symbol for a theoretical current source. Most people use Fig. 2(a), but there are two reasons why they should not: it is an international standard symbol for a transformer, and it doesn't suggest either the dual of a voltage source or a non-conducting path. So I use a dotted line to make clear the absence of conductance, and either the non-committal sine-wave symbol for a.c. or the letter I, Fig. 2(b).

Duality can be applied directly to "equivalent generators." A practical voltage generator has internal impedance, and can be represented in circuit diagrams for algebraical purposes by an ideal generator in series with an appropriate impedance. Dualwise, an actual current generator can be represented by an ideal current generator in parallel with an appropriate admittance. Fig. 3(a) shows the well-known equivalent generator which, for signals only, can be substituted for a valve.

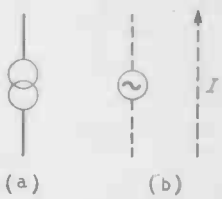


Fig. 2. The symbol (a), though often used to denote an ideal current generator, is unsuitable; (b) shows two possible alternatives.

Here μ and r_a are the voltage amplification factor and anode a.c. resistance respectively, and v_g is the signal voltage at the grid with respect to cathode. (I prefer to use v_{kg} for this, or even just kg, but am making a concession to common usage.)

If one were constructing a dual of the whole valve one would have to replace it by a current-operated device (e.g., a transistor). But when it is an actual valve it is more helpful to retain its voltage-control element, the grid, and just express the output side in its alternative current generator form. The series anode resistance is replaced by the parallel anode conductance, $g_a = 1/r_a$, in Fig. 3(b).

To be really equivalent these two must appear the same to any load connected to the terminals, so let us connect a short circuit to (a) and so find that the current therein is $-\mu v_g/r_a$. It must be the same in (b), and as this is equal to the current put into it by the generator it too is $-\mu v_g/r_a$. Since $\mu/r_a = g_m$, this is equal to $-g_m v_g$ as shown, g_m being the mutual conductance of the valve.

I should like to emphasize that *any* valve can be represented in either of these two ways, and both yield the same answers; but (b) is more convenient than (a) for valves of pentode type, especially if the load is made up of items in parallel.

Returning now to the aside about notation for voltages, I said I denoted the voltage at g with respect to that at k by V_{kg}. There are those who would call it V_{gk}. The latter usage is quite workable within a restricted field, but if one goes out for an integrated system embracing such things as phasor ("vector") diagrams and such well-established conventions (in graphs and other things besides voltage notation) as that "up" is positive and "down" is negative, one is driven to the conclusion that V_{gk} should mean the voltage change on passing from g to k.* The usual custom in common-cathode circuits is to take account of the change on passing from k to g; hence $-V_{kg}$.

People who use a double-subscript notation for voltages—either of the two opposite varieties just mentioned—presumably think it is a good idea, because it indicates both the voltage and its direction (unlike the absurd arrows pointing *both* ways that are still often used) so why not for currents too? Up to that point the line of thought is impeccable, but unfortunately it almost invariably goes astray from there on. The thinker says to himself that if V_{ab} means the voltage between a and b then I_{ab} should mean the current flowing from a to b. He would get away with this in circuits like Fig. 1(a), where the junctions between the resistors might be marked a, b, c, etc. But what about Fig. 1(b)? There are four currents flowing between the only two circuit junctions and they are probably all different. That will never do, so he finishes up by distinguishing them as I_{R1}, I_{R2}, etc., sacrificing the indication of direction in the process. All very arbitrary and unsatisfactory.

If only he had remembered the table of duals he would have realized that current is the dual of voltage, so if the voltage subscripts refer to circuit junctions the current subscripts should refer to circuit meshes. This is perfectly specific and unambiguous; the current flowing through, say R_1 in Fig. 1(b), is not specified by the points between which it flows, for three other currents do the same, but it is uniquely specified by the meshes on each side of R_1. This is not even a revolutionary new idea; it was used for stresses in structures by Bow nearly 100 years ago.

If V_{ab} means the change in voltage on passing from point a to b, then I_{JK} (say) means the change in current on passing from mesh J to K. Just as, according to this notation, v_{ab} is positive if b is at a higher (i.e., more positive) potential than a, I_{JK} will be positive if the current around mesh K is more positive than that around J. There is a well-understood convention that b is more positive than a if electrons show a tendency to desert a in favour of b. (I would say that positive charges tend to move from b to a if somebody wouldn't be sure to jump up and ask what a positive charge is and why.) There is also a convention, probably less well understood, about mesh currents. For easing multi-mesh calculations, the great Maxwell suggested the concept of mesh or circulating currents, according to which each mesh is imagined to have a current circulating around

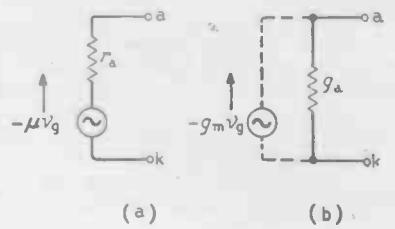


Fig. 3. Dual valve "equivalent generators": (a) voltage; (b) current.

it, the actual current in any conductor being the difference between the currents in the meshes separated by it. The difference, because all the mesh currents are supposed to have the same direction of rotation, so in any conductor they flow in opposite directions. This can be seen in Fig. 4, where the current through R_1 is clearly $I_L - I_K$, which is the meaning we can appropriately give to I_{KL}, just as $V_{ab} = V_b - V_a$.

Strictly speaking, V_a and V_b are meaningless, since the potential at any point is indeterminate unless given an

* The reasons are more fully given in *Essays in Electronics*, Chapter 12.

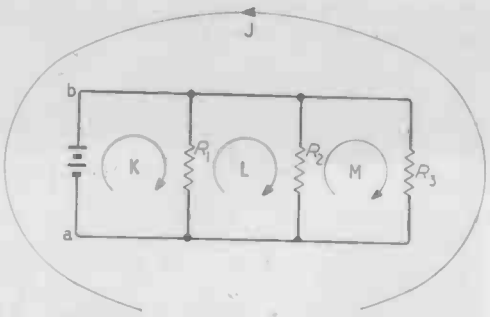


Fig. 4. Fig. 1(b) repeated with junction and mesh labels, to show circulating currents.

arbitrary figure or related to some other potential. Thus the potential of an earthed point is said to be zero. But $V_b - V_a$, or V_{ab}, is definite, because any constant that may be added to both of them cancels out in the difference. Similarly there are an infinite number of sets of mesh currents that could be equal to any set of actual currents, but these are reduced to one set by assuming that the current in the mesh formed by the circuit perimeter is zero. So in Fig. 4 I_{JK}, the actual current through the generator $= I_K - I_J$, $= I_K$ because $I_J = 0$.

The usual convention is for all the mesh currents (except the peripheral mesh) to flow clockwise. So for I_{KL} to be positive, I_L must be greater than I_K; in other words, a positive I_{KL} is one flowing from right to left as one passes from K to L.

I use capital letters to distinguish currents from voltages, because that renders the repeated symbols I, V and E superfluous, so there is no need for the junction and mesh designating letters to be subscripts. This greatly eases the labours of the typist and no doubt those of the compositor too. By using different letters for currents and voltages, as in Fig. 4, one avoids any oral confusion of AB with ab.

These notations and conventions lead to a simple and clear system of phasor diagrams, perfectly integrated with well-known electrical laws, principles, rules and conventions, including (as we have seen) Maxwell's concept of mesh currents. But there is not room to go into that here.

There is yet another field for duality—laws. Kirchhoff's voltage law in its original form fails to follow the dual pattern of his current law and obliges one to distinguish between e.m.fs. and voltage drops. When the law is extended to include a.c., this is sometimes difficult to do†—and quite unnecessary. So only misplaced sentiment will hinder the bringing of the voltage law into line with the current law and expressing it more neatly and simply as: Around any mesh the sum of the voltages is zero. This can be written in symbols

$$\Sigma V \equiv 0$$

or, in our notation,

$$ab+bc+cd+\ldots\ldots+na\equiv 0$$

where a, b, etc. are consecutive points around a mesh.

The precise dual of this would read: Around any junction the sum of the currents is zero. And correspondingly

$$\Sigma I \equiv 0$$

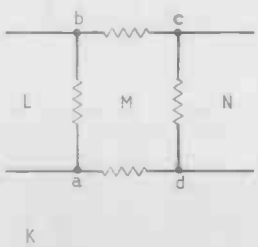
or

$$AB+BC+CD+\ldots\ldots+NA\equiv 0$$

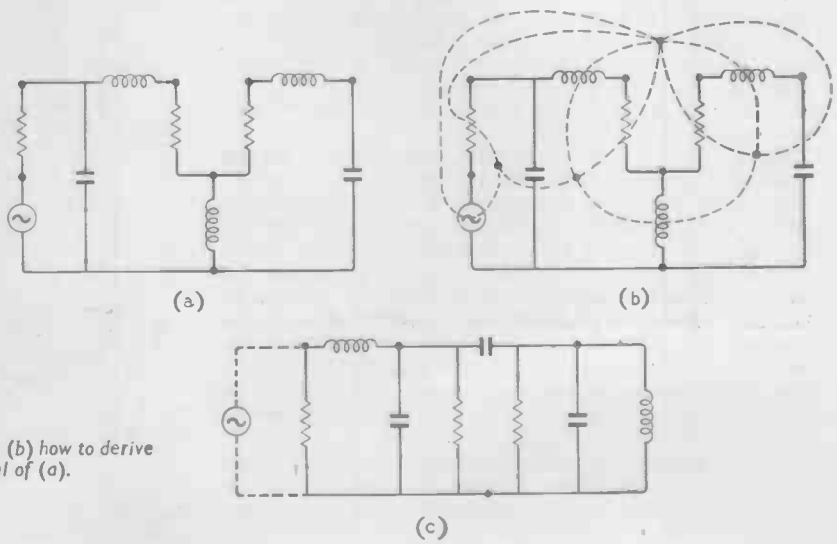
The above form of the current law, an abbreviated version of one suggested by Mr. C. E. Newton, may need a little explanation. Just as in Fig. 5 the voltages ab+bc+cd+da around mesh M add up to zero, so the currents KL+LM+MK (say) around junction a add up to zero, as do those around any of the other junctions. The words "mesh" and "junction" are used in the above statements of Kirchhoff's laws because they are applied to circuits, but the laws are equally true around any enclosures, even in open space. The sum of the changes in potential around any closed path is equal to zero, and so is the sum of the currents into any enclosed space, if Maxwell's displacement currents are included.

Note how the notation provides an automatic check of Kirchhoff's equations, as used in circuit calculations. The letters show completeness of path by forming a continuous sequence ending at the start.

†"E.M.F.", *Wireless World*, July and August 1964.



Above:—Fig. 5. Part of a circuit network for illustrating Kirchoff's laws.



Right:—Fig. 6. (a) Example of a circuit; (b) how to derive the dual configuration; (c) complete dual of (a).

A useful circuit theorem that has its dual is Thévenin's (or Helmholtz's). The dual is known as Norton's theorem. But as I wrote about this as recently as the January, 1964 issue perhaps it can be taken as read.

A more timely exercise would be to note the procedure for obtaining the dual of a circuit (I nearly said "any circuit," but see later). Because the dual of a mesh is a junction, we begin by putting a dot in each mesh to form the junction of the dual circuit. Don't forget the external mesh. Then we join these dots by lines to form meshes around each junction. Lastly we include in these lines the symbols of circuit elements that are the duals of the elements crossed by the lines. So if two junctions in the original circuit were joined through an inductor, the part of the new circuit passing between these junctions would have to contain a capacitor.

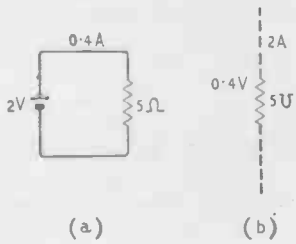


Fig. 7. Extremely simple example of duals with particular values.

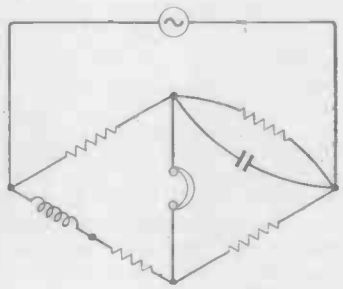


Fig. 8. Maxwell bridge circuit, which is its own dual.

Fig. 6 is an example, where the original circuit (a) has 4 meshes and 7 junctions, so its dual, found as shown at (b) and redrawn separately at (c), must have 4 junctions and 7 meshes. And of course the dual of (c) is (a). Note how series tuned circuits become parallel ones, and inductive coupling becomes capacitive. All equations relating to (a) have their duals relating to (c), obtained by simply changing over the symbols according to the list. But how about the actual component values, currents and voltages in (b), given those in (a)?

Fig. 7 (a) shows a very simple example, with all the quantities marked. In its dual (b), if we assume the numerical values pass over unchanged we do find that it still checks: a current of 2 amperes passing through a conductance of 5 mhos gives rise to 0.4 volt across it. But it is quite possible—and for some purposes convenient—to have a dual circuit configuration with different values. In such a simple circuit as Fig. 7 there would be no difficulty in prescribing any values one pleased for two of the quantities and calculating the third by equation (a). But in more complicated circuits where use of duality would be really worth while, much of its effort-saving would be wasted if one had to calculate new values throughout.

So it is perhaps worth knowing that a conversion factor can be used, having the dimensions of resistance (or impedance), to change from a certain number of amps to a different number of corresponding volts in the dual. Call this factor k. Then, if subscript 1 refers to the original circuit and 2 to its derived dual,

$$\frac{V_1}{I_2} = k \quad \therefore I_2 = \frac{V_1}{k}$$

$$\frac{V_2}{I_1} = k \quad \therefore V_2 = kI_1$$

$$R_2 = \frac{V_2}{I_2} = \frac{k^2 I_1}{V_1} = k^2 G_1$$

$$G_2 = \frac{I_2}{V_2} = \frac{V_1}{k^2 I_1} = \frac{R_1}{k^2}$$

This means that if we want the dual voltage (V_2) of a current (I_1) to be numerically equal to k_1, every dual voltage must also be k times its corresponding current, every dual current must be $1/k$ times its corresponding voltage, every resistance, impedance, reactance or inductance must be k^2 times its corresponding conductance, admittance, susceptance or capacitance, and every conductance, admittance, susceptance or capacitance must be $1/k^2$ times its corresponding resistance, impedance, reactance or inductance. So (using this sledge-hammer to crack the nut of Fig. 7) if we want 1.2V in Fig. 7 (b) our k is $1.2/0.4=3$, so besides the voltage being $3\times0.4=1.2$ the current must be $2/3=0.67$ and the conductance must be $5/9=0.56$. Similarly, we can choose any other ratio between one of the above four classes of duals, but the ratios of all the others are thereby fixed.

Duality can be useful for discovering alternative circuits that may be more convenient in practice; for example, Fig. 6 (c) with its capacitive coupling might cost less to manufacture than Fig. 6 (a), or *vice versa*. Then it is sometimes helpful to realize that two types of circuit that appeared to be quite different are duals of one another, so they behave correspondingly and all the equations for one can be easily derived from those for the other. Usually the dual is a different circuit, but not necessarily. Fig. 8 shows the Maxwell bridge circuit, the dual of which is the

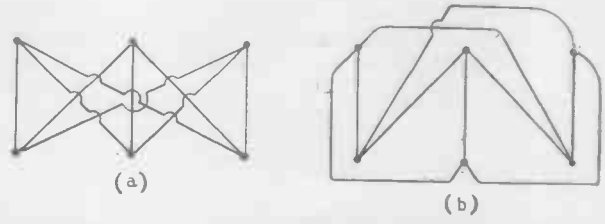


Fig. 9. The simplest network for which no dual exists: (a) in symmetrical form; (b) redrawn to reduce cross-overs to the minimum (one).

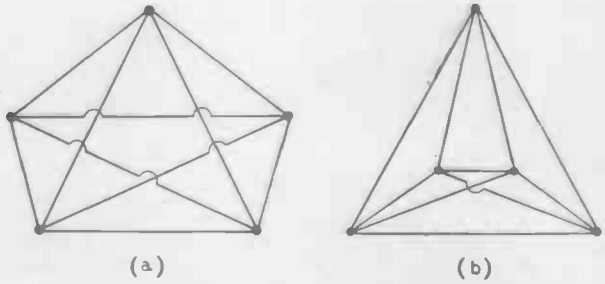
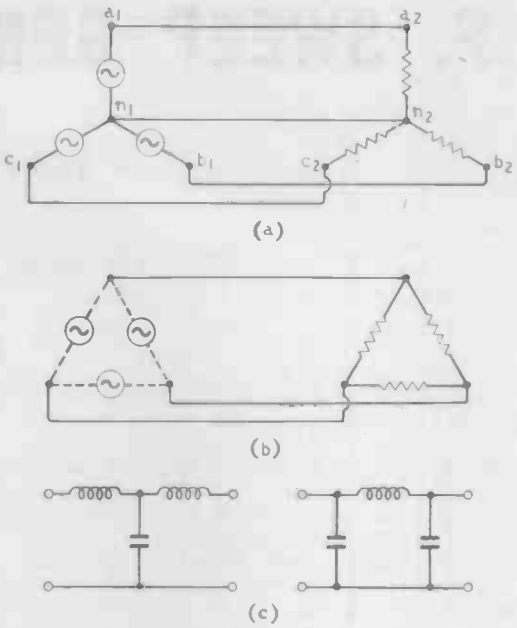


Fig. 10. Another dualless network, again (a) in symmetrical form and (b) with minimum crossing.

Fig. 11. (a) Three-phase star-connected system; (b) its dual, delta-connected; (c) identical with the foregoing modes of connection are the T and Π.



same except for the change from voltage to current generator. Obviously circuits of this kind must have the same number of meshes as junctions, and the same number of inductances as capacitances.

Finally, some circuits have no dual. It has been shown* that duality exists only if the circuit diagram can be drawn on a flat sheet of paper with no wires crossing. That might seem to rule out rather a lot, but in fact most basic circuits can be drawn without crossings. The simplest exception is shown in Fig. 9 (a). It is the basis of a celebrated puzzle, in which three of its points are supposed to be houses and the other three are sources respectively of gas, water and electricity; and the problem is to supply all three houses with all three services without any feeds crossing. It is not difficult to reduce the number of crossings to one—Fig. 9 (b)—but there one sticks.

Another relatively simple dual-less circuit is shown in Fig. 10, (a) being its most symmetrical form and (b) as redrawn with the irreducible minimum of one crossover. In Figs. 9 and 10 I have not bothered to draw the components that are supposed to exist between every pair of points.

Fig. 11 (a) is familiar to all electrical power engineers as a three-phase star-connected system. Drawn in this rather pictorial manner, two wires cross, but this can easily be avoided by interchanging b_2 and c_2 without affecting the circuit. The dual can then be drawn and turns out to be the equally familiar three-phase delta-connected system—Fig. 11 (b). These might be considered irrelevant in *Wireless World* were the star and delta configurations not identical with those well known to us all as the T and Π (c), for these are the basis of all filters and attenuators. They can be regarded as duals of one another.

*By B. D. H. Tellegen in *Philips Technical Review*, Vol. 5, No. 11 (Nov. 1940), pp. 324-330.

BOOKS RECEIVED

Nonlinear and Parametric Phenomena in Radio Engineering, by A. A. Kharkevich. In many of the processes encountered in radio—rectification, oscillation, etc.—the equations involved have variable coefficients or coefficients which depend on the function or its derivatives. This book, translated from the Russian, gives the basic mathematical equipment to tackle such problems and gives examples of its application. Pp. 190. John F. Rider Inc. New York, and published in Great Britain by Iliffe Books Ltd., Dorset House, Stamford Street, London, S.E.1. Price 35s.

The Elements of Pulse Techniques, by O. H. Davie, M.I.E.E. Covers generation, amplification, delay, measurement and application of electrical pulses, with emphasis on physical explanation rather than mathematical analysis. Aimed at students and technicians. Pp. 197. Chapman & Hall Ltd., 11 New Fetter Lane, London, E.C.4. Price £1 15s.

Guide Technique de l'Electronique Professionelle. Fourth Edition (1964/5) of a buyers guide to the French electronics industry, including foreign firms represented in France. In two volumes (weighing over 12 lb). Pp. 1,352. Publéditec, 13, rue Charles Lecocq, Paris 15e. Price (including packing and postage) 130F (but 160F in France).

Solid Circuits and Microminiaturization, proceedings of a conference held at West Ham College of Technology, June 1963, edited by G. W. A. Dummer, M.B.E., M.I.E.E. Contains 28 papers and five discussions on various aspects of the technology, including circuit design, manufacturing methods, descriptions of particular circuits and application to electronic equipment. Pp. 346. Pergamon Press Ltd., Headington Hill Hall, Oxford. Price £3.

Basic Electric Circuits, by A. M. P. Brookes, M.A., A.M.I.Mech.E., provides a grounding in the elements of circuit analysis for university and technical college students. It examines basic resistance, capacitance and inductance circuits and combined RCL circuits. A.C. theory, vectors and transients are dealt with briefly. Pp. 134. Pergamon Press Ltd., Headington Hill Hall, Oxford. Price 10s.

Radio Receiver Design. Part 1: Radio-frequency Amplification and Detection, by K. R. Sturley, Ph.D., M.I.E.E. Completely revised third edition of this standard work in which the application of transistors, where appropriate, has been afforded the same thorough treatment as is given to valves. Pp. 937. Chapman & Hall Ltd., 11, New Fetter Lane, London, E.C.4. Price 105s.

Transistor Bandpass Amplifiers, by W. Th. H. Hetterscheid. Mathematical treatment of the theory of design of single- and multi-stage amplifiers, including neutralization. (A complementary volume on the design and construction of i.f. amplifiers for radio, television and radar is in course of preparation). Pp. 314. Philips Technical Library, Cleaver-Hume Press Ltd., 10-15, St. Martins Street, London, W.C.2. Price 76s.

Aerial Handbook, by G. A. Briggs with R. S. Roberts, M.I.E.R.E., as Technical Editor. Another entertaining book from Wharfedale. Instead of audio the author's topic is this time radio (including television) with the aerial as the central, though by no means the only theme. The introduction says: "The book is not for the expert but for the reader who would like a little mystery taken out of that piece of wire." Pp. 144. Wharfedale Wireless Works Ltd., Idle, Bradford, Yorks. Price 8s 6d.

I.F. SWEEP GENERATOR

TRANSISTOR CIRCUIT FOR 465 KC/S AND 1.6 MC/S

By M. W. RIGNALL*

ALIGNMENT of many i.f. amplifiers may be done with a signal generator and output meter. If, however, a crystal filter is incorporated this is no longer possible except by a laborious point by point plot. For such amplifiers, a sweep generator and oscilloscope provide the only acceptable means of alignment. The unit described is capable of sweeping a 25 kc/s range at any point in the 450 kc/s and 1.6 Mc/s i.f. channels.

The operation of the swept oscillator depends upon the change of input reactance of a grounded-base oscillator as its emitter current is varied by the voltage derived from the horizontal scan. The magnitude of the input reactances at the chosen frequency is dependent upon the f_1 of the transistor, hence for a low-frequency device the input reactance is low. Thus for a given change of emitter current, the corresponding frequency change will be larger than in a high frequency transistor.

Circuit Function

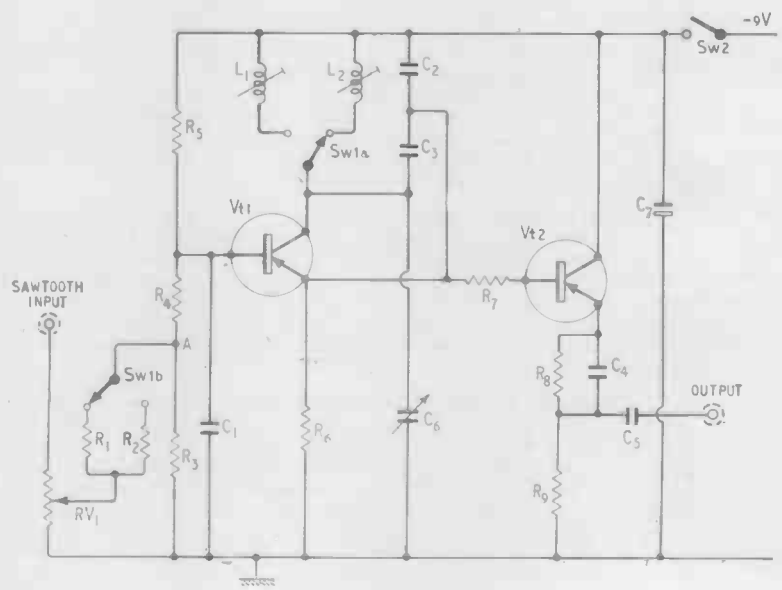
The practical circuit is shown in Fig. 1. A grounded base oscillator employing an OC170 is biased by the normal potentiometer circuit R_1-R_6, which establishes the unswept d.c. condition. The sweep voltage from the oscilloscope is passed via the deviation control RV_1 through a resistor R_1 or R_2 to the point A, thus varying the voltage at this point and adding a linearly increasing voltage to the base potential. The resultant change of emitter current varies the transistor reactances over a range governed by the magnitude of R_1 and R_2. Over the small range required the deviation is almost linear, but since the tuning capacity is greater at the l.f. end of a range and the swept reactance is constant, the deviation for a fixed setting of RV_1 will be lower at the l.f. end than the h.f. end. Figs. 2(a) and 2(b) show the deviation plotted against sweep voltage for both ranges.

Sw1a selects the appropriate inductance for the range required, while Sw1b adjusts the swept current flowing into point A by selection of R_1 or R_2. This adjustment is necessary because the swept current must be reduced for the 1.6 Mc/s range, where a 25 kc/s sweep represents only a 1.6% deviation, in comparison with 5.5% at 450 kc/s. It should also be noted that the deviation, being dependent upon a change of working point, will also vary with the supply voltage since the sweep voltage at point A will be added to a reduced voltage as the battery discharges. This variation is plotted on Fig. 3.

Changes of ambient temperature do not measurably affect the deviation, but move the mean frequency by approximately 4% for a 25°C variation.

The sweep input required is 150 V peak, which is obtainable from several widely used measuring oscilloscopes. This may be readily modified for the 20 V sweep output from the "Wireless World" 'scope by substituting the input circuit of Fig. 4.

* The Marconi Company Ltd.



Left:—Fig. 1. Circuit diagram of sweep generator arranged for 150V sawtooth input

Above:—Prototype sweep oscillator.

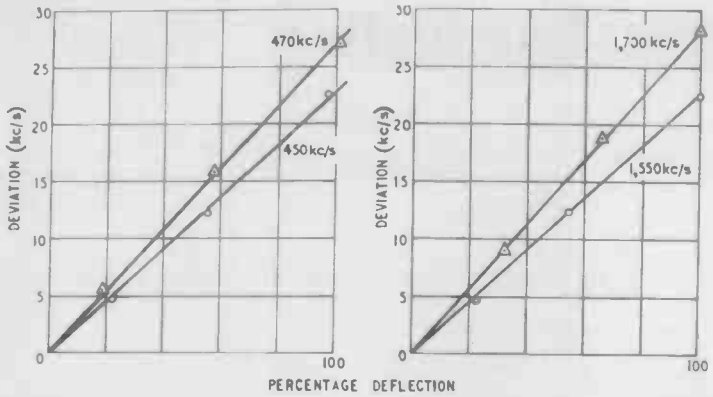


Fig. 2. Deviation plotted against input voltage for both frequency range.

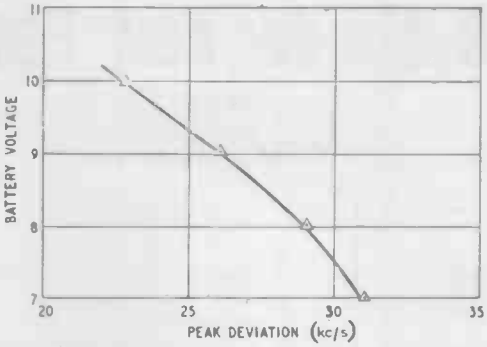
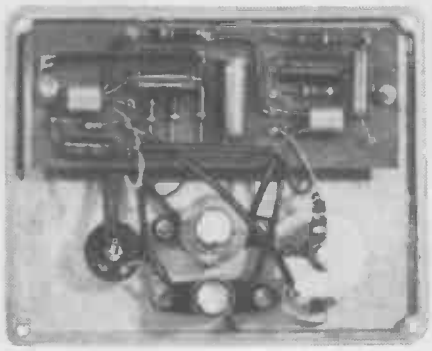


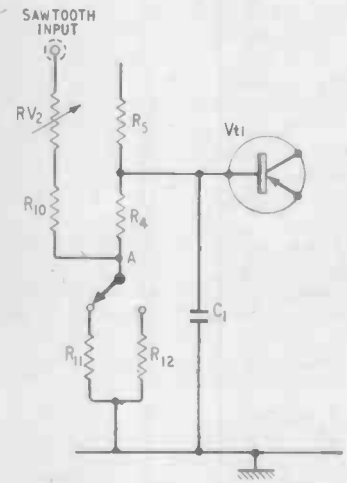
Fig. 3. Reduction of maximum obtainable deviation with decreasing battery voltage.

Since the deviation is a function of the f_t of the oscillator transistor, the values of R_1 and R_2, R_{11} and R_{12} in Fig. 4 should be selected for the particular transistor used.

The swept output is taken through an emitter follower, giving an output of approximately 0.1 V r.m.s. from a 75Ω source.



Above:—Sweep oscillator component layout.



Right:—Fig. 4. Input circuit to accept 20V sawtooth input.

Construction

The complete unit is easily accommodated in an Eddystone die cast box, Type 650. The layout is shown in the photos. The components are mounted on a tagboard with turret lugs; the layout is, however, not critical, and any of the usual methods of construction may be adopted. The battery, a Vidor VT4 or equivalent, while not shown, is mounted on the floor of the box.

Testing

The first step is to adjust the cores of L_1 and L_2 to the correct ranges. With C_6 set to the maximum, the frequencies on the appropriate ranges (with no deviation) should be adjusted to 440 kc/s and 1,550 kc/s. A digital counter is the ideal setting-up device, but in the absence of a counter a communication receiver may be used. Many such receivers will have an i.f. in the 450 kc/s region. In this case the second harmonic of the generator may be used, noting however that the deviation must be set at 50 kc/s.

With the minimum frequencies set, a direct voltage equal to the peak sweep output should be applied to the sweep input socket with the deviation control set to maximum, i.e. RV_1 slider connected to the sweep input socket (or RV_2 at minimum).

The resistors R_1 and R_2 (or R_{11} and R_{12}) may be then adjusted to give a deviation of 25 kc/s. The approximate values for the correct sweep amplitude will be 100 kΩ and 33 kΩ for the 1.6 Mc/s and 450 kc/s ranges respectively of the circuit of Fig. 1, and 390Ω and 1 kΩ in the circuit of Fig. 4.

Several of these sweep generators have been assembled for the Marconi Company's internal use and all are giving satisfactory performances. It must be stated, however, that no manufacture for external sale is contemplated.

The author wishes to thank the Director of Engineering & Research of the Marconi Company for permission to publish this article.

Component List

R_1, R_2	See text	All 1/8 W ±10%	
R_3	1kΩ		
R_4	4.7kΩ		
R_5	6.8kΩ		
R_6	2.2kΩ		
R_7	15kΩ		
R_8	330Ω		
R_9	82Ω		
R_{10}	4.7kΩ		
R_{11}, R_{12}	See text		
C_1, C_4, C_5		0.04μF paper	250V
C_2		0.02μF paper	250V
C_3		470pF polystyrene	250V
C_6		100pF air spaced variable	
C_7		25μF 12V electrolytic	
VT1, VT2		Mullard OC 170	
L_1	30T	Layer wound in 5 slot bobbin 15/48 stranded	On Aladdin Former No. PP5892 Core No. PP5804
L_2	120T		
RV_1		25kΩ	
RV_2		50kΩ	

Cathode and Emitter Decoupling

By J. F. YOUNG, C.G.I.A., A.M.I.E.E., A.M.I.E.R.E.

MOST electronic engineers use a certain number of "rules of thumb" in their work. Such rules of thumb are excellent in many ways since they remove the necessity always to think out problems from basic principles and so they can save a lot of the engineer's valuable time. However, such rules require occasional re-examination in order to bring them up to date as engineering techniques change. In some cases rules which have been perfectly adequate in the past become quite useless and must be rejected completely.

One rule which the writer often hears quoted is that the reactance of a cathode (or emitter) by-pass capacitor should be about one tenth of the cathode (or emitter) resistor value at the lowest operating frequency. Indeed, this rule appears in at least one respectable handbook. Now if it is a good rule, then it is sensible to use the highest possible value of cathode (or emitter) resistor in order to minimize either the lowest operating frequency or the size of capacitor required. In turn this implies the adoption of a high supply voltage so that at a given current a higher value of resistor can be used. Is this the true position? In order to find out we have to analyse the circuits mathematically.

Considering firstly the valve case, in Fig. 1 we obtain an expression for the gain:

$$\frac{v_o}{v_i} = \frac{\mu Z_L}{Z_L + r_a + (\mu+1)Z_k} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

(It is worth noting in passing that this is the gain which would be obtained with a valve having an anode slope impedance of $r_a+(\mu+1)Z_k$. We make use of this fact if we want to increase the effective anode resistance of a triode so that it can be used as a constant current source.[1]) Now in the usual amplifier circuit of Fig. 2, Z_k takes the form of a cathode bias resistor R_k by-passed by a capacitor C_k. Also the load Z_L takes the form of a resistor R_L. Therefore in this case the cathode circuit impedance can be written as:—

$$Z_k = \frac{R_k}{1+j\omega C_k R_k} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

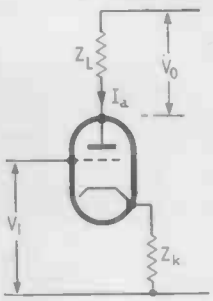


Fig. 1. Valve amplifier stage with cathode impedance Z_k.

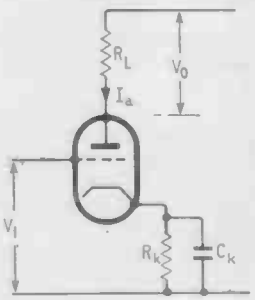


Fig. 2. Valve stage with cathode by-pass capacitor C_k.

Now if the values of Z_k and Z_L are substituted into equation (1), the gain becomes:—

$$\frac{v_o}{v_i} = \frac{\mu R_L(1+j\omega C_k R_k)}{(R_L+r_a)(1+j\omega C_k R_k) + (\mu+1)R_k} \quad \ldots\ldots \quad (3)$$

Equation (3) can be rewritten as:—

$$\frac{v_o}{v_i} = \frac{\mu R_L}{R_L + r_a + (\mu+1)R_k} \times \frac{1 + j\omega C_k R_k}{1 + j\omega \frac{C_k}{\mu+1} \times \frac{(R_L+r_a)(\mu+1)R_k}{R_L + r_a + (\mu+1)R_k}} \quad \ldots\ldots \quad (4)$$

Equation (4) is not really as complicated as it looks at first sight. The first term on the right:—

$$\frac{\mu R_L}{R_L + r_a + (\mu+1)R_k}$$

should be compared with equation (1). It is the gain which would be obtained if the capacitor C_k was not there at all. Since in these circumstances Z_k would simply be equal to R_k, the first term is completely independent of frequency. The second term on the right of equation (4) depends on the frequency, however, and

SYMBOLS

μ	valve amplification factor.
Z_L	load impedance.
r_a	valve anode slope resistance.
Z_k	cathode circuit series impedance.
R_k	cathode circuit resistance.
C_k	cathode by-pass capacitor.
ω	angular frequency $2\pi f$, where f is the operating frequency.
R_L	load resistance.
g_m	valve mutual conductance.
I_e	transistor emitter current.
I_b	transistor base current.
I_c	transistor collector current.
α	transistor emitter to collector current gain.
Z_1	base circuit series impedance.
Z_e	emitter circuit series impedance.
R_e	transistor emitter resistance.
R_2	emitter circuit resistance.
C	emitter by-pass capacitor.
R_1	base circuit resistance.

his term determines the frequency response of the amplifier. The second term takes the form :—

$$\frac{1 + j\omega C_k R_k}{1 + j\omega CR}$$

where

$$C = \frac{C_k}{\mu + 1} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

and

$$R = \frac{(R_L + r_a) \times (\mu + 1)R_k}{R_L + r_a + (\mu + 1)R_k} \qquad \ldots\ldots \quad (6)$$

The imaginary resistor R can therefore be thought of as formed from $(R_L + r_a)$ in parallel with $(\mu + 1)R_k$, while the imaginary capacitor C is $(\mu + 1)$ times smaller than C_k.

Because of the presence of this frequency response term in the gain equation (4), we can see that the overall gain of the circuit of Fig. 2 is not independent of frequency. Instead, when the gain in decibels is plotted against the logarithm of frequency, a curve such as that of Fig. 3 is obtained. From equation (4) we can see that at very low frequencies, when ω is very nearly zero, the gain becomes:—

$$\frac{v_o}{v_i} = \frac{\mu R_L}{R_L + r_a + (\mu + 1)R_k} \qquad \ldots\ldots \quad (7)$$

since the frequency response term equals one when $\omega = 0$. On the other hand, at very high frequencies, when ω approaches infinity, equation (4) gives a gain of:—

$$\frac{v_o}{v_i} = \frac{\mu R_L}{R_L + r_a + (\mu+1)R_k} \times \frac{R_L + r_a + (\mu+1)R_k}{R_L + r_a} \quad (8)$$

$$= \frac{\mu R_L}{R_L + r_a} \qquad \ldots\ldots \quad (9)$$

As might be expected, at high frequencies capacitor C_k removes the negative feedback, gain-reducing, influence of cathode resistor R_k. This is of course the reason for including C_k in the circuit in the first place.

Thus we know the low frequency gain and the high frequency gain. From equation (4) and Fig. 3 we also know the frequencies at which occur the "cut-off" points, where the characteristic curve departs by approximately 3 decibels from the low frequency and high frequency gain values. Now since capacitor C_k was added to increase the gain at any but the lowest frequencies, we are interested in the value f_1 of the lowest frequency at which the capacitor is very effective in holding up the gain. From Fig. 3 it can be seen that this lowest frequency is given by:—

$$\omega_1 = 2\pi f_1 = \frac{1}{CR} = \frac{R_L + r_a + (\mu + 1)R_k}{C_k R_k (R_L + r_a)} \qquad \ldots \quad (10)$$

Simply in order to make more sense out of equation (10), let us make the assumptions that $(\mu + 1)R_k$ is so much greater than $(r_a + R_L)$ that we can neglect the latter and also that r_a is so much greater than R_L that we can neglect R_L. On the basis of these assumptions:—

$$\omega_1 \approx \frac{\mu}{C_k r_a} \approx \frac{1}{C_k \times 1/g_m} \qquad \ldots\ldots \quad (11)$$

Thus, insofar as the assumptions are acceptable, the critical frequency below which the gain falls off fairly steeply depends on the relationship between the cathode by-pass capacitor value and the mutual conductance of the valve. The value of the cathode resistor is not very important in settling the required capacitor value. On the other hand the gain stops falling below a frequency f_2 given by :—

$$\omega_2 = 2\pi f_2 = \frac{1}{C_k R_k} \qquad \ldots\ldots \quad (12)$$

This frequency is clearly very dependent on the value of R_k. However, we are not normally very interested in the value of ω_2, our main interest is in the lowest frequency at which the capacitor is effective in maintaining the gain high, and this is determined by ω_1.

The argument so far is wide open to criticism in that some pretty wild assumptions have been made. In order to clear this up it will be as well to put a few typical values into our equations and to see what the numbers look like. Suppose we take a typical triode and operate it at -1 volt on the grid with an anode current of about 3.7 mA. Under these conditions r_a is 13.5 kΩ, g_m is 4 mA/V and μ is 54. Now suppose R_L is 39 kΩ. In order to obtain -1 volt of grid bias at 3.7 mA, a 270 Ω cathode resistor R_k is required. With these values :—

$$CR = \frac{C_k \times R_k (R_L + r_a)}{R_L + r_a + (\mu + 1)R_k} \qquad \ldots\ldots \quad (13)$$
$$= C_k \times 211\,\Omega$$

Now g_m is 4 mA/V, so $1/g_m$ is 250 Ω and the approximation involved in equation (11) would give in this case a reasonable answer. However, also in this case R_k is 270 Ω so that the rule of thumb, which might be expressed as $CR = C_k R_k$, is not too bad an approximation either. In fact, of course, the only reason that the rule of thumb works at all is that in most of our circuits R_k is not terribly different from $1/g_m$. However, suppose that we keep all conditions the same except that we make R_k to a negative rail so that we can use a higher value of resistor. Can we then reduce the value of capacitor C_k without changing the cut-off frequency? Suppose that we increase R_k by nearly 40 times to 10 kΩ, can we reduce the value of C_k by 40 times and yet still obtain the same cut-off frequency? To obtain the answer, we examine the value of CR in this case. On substituting the correct values, including the new value of R_k, into equation (13), we find that :—

$$CR = C_k \times 873$$

Thus we can indeed reduce the value of C_k without

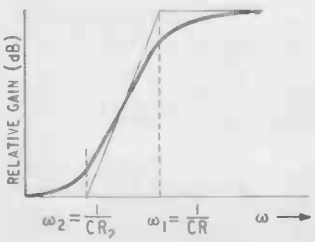


Fig. 3. Variation with frequency of valve stage gain.

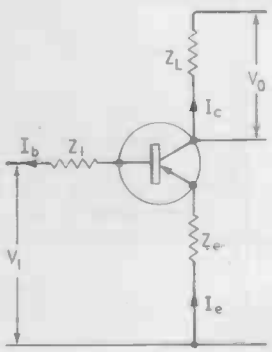


Fig. 4. Transistor amplifier stage.

changing the cut-off frequency, but only by about four times rather than forty times. If a rule of thumb is required, the only safe one is that the reactance of capacitor C_k should be low (say less than ten times) compared with $1/g_m$, rather than compared with R_k, at the lowest operating frequency.

With valves at least the usual rule of thumb is satisfactory for use with normal amplifier circuits, even if this is just a lucky accident. What of transistor emitter by-pass capacitors, what value should they have? Here some people carry over the rule of thumb from valve circuits and say hopefully that the emitter by-pass capacitor should have a reactance of one tenth of the emitter resistor value at the lowest operating frequency. After our experience with the valve case, it will be as well to defer comment until the circuit has been analysed.

In the transistor circuit of Fig. 4, we can say without doubt that $I_e = I_b + I_c$. If required, Kirchhof can be invoked but it would seem to be common sense that what goes in must come out somewhere. In addition, let us make the assumption that $I_c = \alpha I_e$, where α is a constant. This is an assumption which we can use safely at low frequencies with small signals as we can see from examination of the characteristic curves of a transistor. Accepting these two equations of operation, it is not too difficult to derive for the circuit of Fig. 4 an expression for the collector current I_c :—

$$I_c = \frac{\alpha V_1}{Z_1(1-\alpha) + Z_e} \quad .. \quad .. \quad .. \quad (14)$$

Now suppose that Z_L is a resistor R_L, Z_1 is a resistor R_1 and Z_e comprises a resistor R_2 in parallel with a capacitor C, both in series with a resistor R_e as shown in Fig. 5. Thus :—

$$Z_e = R_e + \frac{R_2}{1 + j\omega R_2} \quad .. \quad .. \quad .. \quad (15)$$

By substituting the various component values into equation (14), we can obtain an expression for the voltage gain of Fig. 5. :—

$$\frac{v_o}{v_i} = \frac{I_c R_L}{v_i} = \frac{\alpha R_L}{R_1(1-\alpha) + R_e + R_2} \times \frac{1 + j\omega CR_2}{1 + j\omega C\dfrac{R_2(R_e + (1-\alpha)R_1)}{R_2 + R_e + (1-\alpha)R_1}} \quad (16)$$

Equation (16) can be compared with equation (4). Once again there is a fixed term and a frequency dependent term, the latter having the form :—

$$\frac{1 + j\omega CR_2}{1 + j\omega CR}$$

where

$$R = \frac{R_2(R_e + (1-\alpha)R_1)}{R_2 + R_e + (1-\alpha)R_1} \quad .. \quad .. \quad .. \quad (17)$$

The imaginary resistor R can be thought of as a resistor R_2 shunted by the series combination of R_e and $(1-\alpha)R_1$. The frequency response obtained with the arrangement of Fig. 5 can be plotted as shown in Fig. 6. In this case :—

$$\omega_1 = \frac{1}{CR} \quad .. \quad .. \quad .. \quad .. \quad .. \quad (18)$$

so that the critical frequency is determined by :—

$$CR = C\frac{R_2(R_e + (1-\alpha)R_1)}{R_2 + R_e + (1-\alpha)R_1} \quad .. \quad .. \quad .. \quad (19)$$

Usually $R_e + (1-\alpha)R_1$ will be small compared with R_2 and the former can therefore be ignored as a first approximation in the denominator of (19). On this assumption :—

$$CR = C(R_e + (1-\alpha)R_1) \quad .. \quad .. \quad .. \quad (20)$$

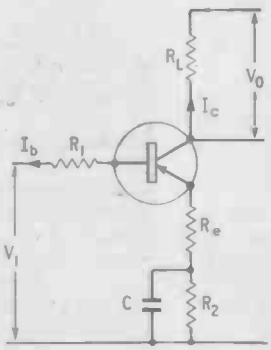


Fig. 5. Transistor stage with emitter by-pass capacitor C.

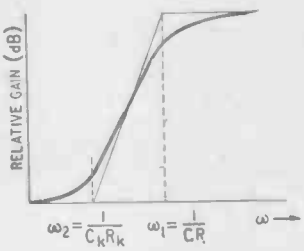


Fig. 6. Variation with frequency of transistor stage gain.

Thus with the transistor circuit, the minimum frequency at which the emitter capacitor C is effective depends largely on R_e, R_1 and α rather than on R_2. The reactance of capacitor C should therefore be small compared with $R_e + (1-\alpha)R_1$ at the lowest operating frequency in order to reduce the amount by which R_2 causes the gain to be reduced, even though R_1 is not in the emitter circuit.

Once again, the insertion of a few typical numerical values will make the position clearer. Suppose that $R_e = 20\,\Omega$, $R_2 = 1\,k\Omega$, $R_1 = 10\,k\Omega$ and $\alpha = 0.99$,

$$\text{then } R = \frac{1000 \times (20 + 10{,}000 \times 0.01)}{1000 + 20 + 10{,}000 \times 0.01} = 107\,\Omega$$

This value is much nearer to $(R_e + (1-\alpha)R_1) = 120\,\Omega$ than it is to $R_2 = 1\,k\Omega$, though if instead we happen to be using a value of R_2 in the region of $100\,\Omega$ then the old rule of thumb would give a reasonable answer. Unfurtunately a value of R_2 as low as $100\,\Omega$ would be likely to lead to thermal problems in many cases.

Thus the old rule of thumb should be used with caution, if it is used at all, in either valve or transistor circuits. However, it is always safe to say that the by-pass capacitor reactance at the lowest operating frequency should be low compared with $1/g_m$ in the valve case and with $(R_e + (1-\alpha)R_1)$ in the transistor case. It is interesting to note that the base series resistance R_1 has a large effect on the temperature stability of a transistor stage as well as on the frequency response.

REFERENCE

1. Young, J. F., A Transistor Characteristic Curve Tracer, *Electronic Engineering*, Vol. 31, p.330, 1959.

MANUFACTURERS' PRODUCTS

NEW ELECTRONIC EQUIPMENT AND ACCESSORIES

Plug-in Sampling Unit

A NEW plug-in unit that converts the existing 530, 540 and 550 series of Tektronix oscilloscopes into d.c. to 1 Gc/s sampling scopes is announced by Tektronix UK Ltd., of Beaverton House, Station Approach, Harpenden, Herts. Known as the 1S1 plug-in, it has internal triggering facilities that extend to over 1 Gc/s, calibrated sweep speeds from 0.1 nsec/cm to 50 μsec/cm and a unique "time magnifier" which allows any part of the display to be magnified up to 100 times horizontally without reducing the display dot density. The sweep speed, even when magnified, is read directly from a single knob.

Calibrated vertical sensitivities range from 2 to 200 mV/cm and a d.c. offset control is provided which allows millivolt signals to be observed in the presence of up to ±1 volt input levels. Provision is also made for driving x-y and y-t chart recorders.

6WW 301 for further details

Power Units for Logic Systems

A MODULAR unit for powering digital logic systems is being offered by Standard Telephones and Cables Ltd. Operating from 210-250 V, 50-60 c/s supplies, it provides 1 A at 24 V d.c. and 0.5 A at −6 V d.c. Separate voltage controls are provided and allow adjustment from 20.6 to 27.6 V on the 24 V rail and from −5 to −7 V on the −6 V rail.

The long and short term stability of the Type 19G power unit over the entire load range—and for 20% input variation—is better than 250 mV on the 24 V rail and better than 60 mV on the −6 V rail. The maximum ripple voltage is quoted to be 1 mV r.m.s. and protection is provided against accidental overload by means of a semiconductor current-limiting circuit. Both rack mounting and bench mounting versions of the Type 19G power unit are available from Electronic Services, S.T.C., Edinburgh Way, Harlow, Essex.

5WW 302 for further details

Small Industrial Relay

A COMMERCIAL version of the Clare Type F "crystal can" relay is announced by Clare-Elliott Ltd., a member of the Elliott-Automation Group. This small two-pole relay designated CF is primarily intended for computer and machine tool applications, and has been tested at speeds up to 30 c/s for 10 million operations without failure.

Sensitivity is 300 mW and maximum operate and release times is claimed to be 5 msec. Other specification details include a typical contact resistance of 25 milliohms (75 maximum) and contact ratings of 28 V d.c. resistive at 3A, 115 V a.c. resistive at 1 A and 88 V d.c. inductive at 1 A.

The company's address is 70 Dudden Hill Lane, Willesden, London, N.W.10.

5WW 303 for further details

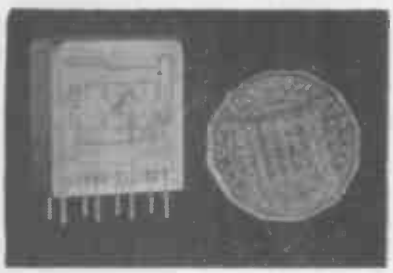
Spark Erosion Machine

A SMALL spark erosion machine suitable for machining extremely small components is announced by the South London Electrical Equipment Company, of Lanier Works, Hither Green Lane, London, S.E.13. This machine, known as the Arcotron, uses a dielectric liquid to reduce the distance between the cutting electrode and the workpiece. This allows a practical working voltage to be used and also serves to cool the operation and by flushing, to carry away the erosion products from the gap.

The Arcotron is capable of cutting slots down to approximately 0.00035 in

Type 1S1 plug-in sampling unit for existing Tektronix oscilloscopes.

S.T.C. Type 19G power unit provides dual outputs suitable for driving analogue/digital converters and system logic circuits.



Small industrial relay, Type CF, from Clare-Elliott Ltd.

Precision spark eroder for use in the manufacture of micro-miniature components and apparatus. It is being made by the South London Electrical Equipment Company.

wide and alignment is to approximately 0.00002 in. A surface finish of approximately 3 microns is obtainable with this bench-mounted machine. Spark rate is about 1 Mc/s.

Applications for this machine in the electronics industry have so far been in the manufacture of evaporation masks, thin film resistor patterns and microwave components such as millimeter wavelength reflex klystrons.

5WW 304 for further details

"Broadcast" Vidicons

THE range of separate mesh one-inch vidicons manufactured by the English Electric Valve Company has been extended with the introduction of two new units having high peak response in the "blue" region of the spectrum. Entirely new photo-surfaces have been incorporated in these tubes, the 8625 (P846) and 8626 (P847), which give high resolution at high signal currents, correct panchromatic response with tungsten illumination, low lag and reduced long term sticking characteristics, and a very high and uniform sensitivity. The improved features have resulted in new manufacturing techniques whereby the photo-surfaces are "prefabricated" to ensure an overall even deposition. The extra blue sensitivity has also been found to improve considerably the signal to noise ratio in colour television cameras. While the 8625 (P846) has the standard 6.3 V/0.6 A heater, the other tube has a low consumption 6.3 V/0.095 A heater.

5WW 305 for further details

General-purpose Bridge

AN instrument containing a resistance-capacitance bridge, a resistance-capacitance-inductance comparator, a capacitance leakage/inductance-resistance analyser, a d.c. valve voltmeter and a d.c. valve ammeter has been introduced by the EICO Electronic Instrument Co. Inc., of 131-01 39th Avenue, Flushing, New York 11352. Called the EICO 965 FaradOhm Bridge Analyser, this instrument is suitable for measuring resistance from 0.5 Ω up to 500 MΩ (insulation resistance up to 100,000 MΩ) and capacitance from 5 pF to 5,000 μF. The internal supply to the bridge is only 0.45 V a.c. (at line frequency) which allows the instrument to be used for testing very low voltage components. An external voltage at a higher frequency and/or voltage may also be used, and an external polarizing voltage may be applied if required.

The six-range valve voltmeter and eleven-range valve ammeter—required for capacitance leakage/inductance-resistance analysis—may be used externally. The full scale voltage ranges cover 1.5 to 500 V d.c. with an input impedance of 10 MΩ on all ranges. Current range, full scale, is from 150 nA to 15 mA and the full scale voltage drop on all ranges is 75 mV.

The price of this instrument in the United States is $129.95.

5WW 306 for further details

Transistor Tester

AVAILABLE either as a kit of parts or ready made is the new Heathkit Model IM-30U transistor tester. It provides facilities for testing most p-n-p and n-p-n transistors and has a 15 μA basic range for leakage measurements. Tests up to 9 volts are effected from internal batteries and provisions are made for connection to external supplies for higher voltage and current tests. The Model IM-30U costs £24 18s 0d in kit form and £35 10s 0d assembled and is available from Daystrom, of Gloucester.

5WW 307 for further details

Small Closed-circuit Camera

ONLY 4½ inches long and weighing under two pounds is the new all-transistor closed-circuit television camera developed by EMI Electronics Ltd., of Hayes, Middx. The camera can operate on 405, 525 and 625 line standards and changing from one to another is achieved simply by pressing a button. The camera head equipment is contained in two sealed stainless-steel cylinders, each 4½ in long and of 1.7 in diameter. The lens head unit, which is fitted with a half-inch vidicon tube, can be up to 100 ft away from the amplifier head unit and is joined to it by cable. Camera control unit and other units comprising the camera channel can be up to 1,000 ft away.

5WW 308 for further details

Counter-timers

THE 3 Mc/s universal counter-timers (Types TM51B and TM51C) introduced last year by Levell Electronics Ltd. are now being produced under a revised specification which increases their top counting frequency to 6 Mc/s. The sensitivity figures are also revised and are as follows: 35 mV up to 300 kc/s, 100 mV at 3 Mc/s and 300 mV at 6 Mc/s. The ageing rate of the crystals has also been improved and now is 2 parts in 10^6/week for the TM51B and 3 parts in 10^7/month for the TM51C.

Both instruments are portable, have five-digit displays and differ only in the stability of the internal 1 Mc/s crystal reference standard. No change is to be made to the type numbers, or the price of the instruments which is £275 for the Type TM51B and £295 for the TM51C. The company's address is Park Road, High Barnet, Herts.

5WW 309 for further details

Klystron Power Supply

A SOLID-STATE power supply has been developed for medium-power klystrons by Microtest Ltd., of 9 Old Bridge Street, Kingston-upon-Thames, Surrey. It offers a fixed, regulated 300 volt output to drive the cathode (resonator), a continuously variable 0 to −300 volt output for the reflector and a 6.3 volt a.c. output for heaters. Current ratings are from zero to 50 mA, zero to 500 μA and 2 A respectively.

The reflector supply can be internally square wave amplitude modulated at frequencies between 900 and 4,000 c/s or externally frequency modulated by means of sawtooth waveforms or sine-waves. Amplitude of the internal modulation is 200 volts and is provided by a valve circuit.

5WW 310 for further details

Voltage Amplifier & Charge Amplifier

TWO new signal conditioning devices for piezoelectric accelerometers, a Type 1-302 voltage amplifier and a Type 1-

INFORMATION SERVICE FOR PROFESSIONAL READERS

To expedite requests for further information on products appearing in the editorial and advertisement pages of *Wireless World* each month, a sheet of reader service cards is included in this issue. The cards will be found between advertisement pages 16 and 19.

We invite readers to make use of these cards for all inquiries dealing with specific products. Many editorial items and all advertisements are coded with a number, prefixed by 5WW, and it is then necessary only to enter the number(s) on the card.

Readers will appreciate the advantage of being able to fold out the sheet of cards enabling them to make entries while studying the editorial and advertisement pages.

Postage is free in the U.K. but cards must be stamped if posted overseas. This service will enable professional readers to obtain the additional information they require quickly and easily.

303 miniature charge amplifier, are announced by the Consolidated Electrodynamics Division of Bell and Howell Ltd., of 14 Commercial Road, Woking, Surrey. Two standard models of the voltage amplifier are available. One is equipped with a voltage limiter and an adjustable voltage control oscillator reference supply, and the other contains an augmenter (power amplifier) that can drive several hundred feet of cable or very low load impedances (down to 1,200) without distortion of the signal.

The Type 1-303 charge amplifier is the first of a series to be introduced by Consolidated. It features low power drain, wide frequency response (5 c/s without the requirement of a long time constant), good stability under extreme environmental conditions, and low output impedance.

Transistors are used in the voltage amplifiers, which weigh 45 grams, and in the charge amplifier which weighs 25 grams.

5WW 311 for further details

Push-Button Reed Switches

A NEW push-button reed switch providing complete separation between the mechanical and electrical functions is being manufactured by Highland Electronics Ltd., of 26-28 Underwood Street, London, N.1. A cylindical magnet connected to the end of the push-button is used to operate a pair of reed switches which are individually encased in glass tubes and mounted in p.v.c. shock absorbers on the outer part of the assembly.

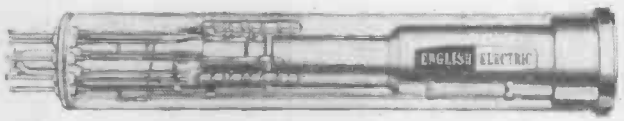
The standard switch is supplied with two make contacts, however, other configurations can be supplied such as two break, one make and one break, and two changeover. The d.c. contact rating varies from 0.5 to 10 watts according to the construction and the type of contact used.

The operating time of the switch, which the makers claim is independent of the speed of operation of the push-button is approximately 500 μsec. Release time is a few microseconds. The magnets in these switches are not demagnetised or influenced by normal stray fields and do not require magnetic shields. At full rating, the life span is 10^7. The approximate dimensions are 2.316 in long by $\frac{3}{4}$ in diameter. Maximum weight is 2 oz.

5WW 312 for further details

"Domestic" Transistors

SEVERAL new transistors have recently been introduced by Mullard Ltd. for domestic receivers, including a series with the trademark TVistor. So far there are four transistors in the TVistor

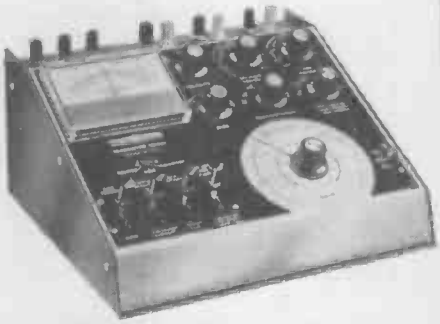


A new photo-surface material has been used on two new one-inch separate-mesh vidicons from the English Electric Valve Company.

EICO Model 956 FaradOhm Bridge Analyser.

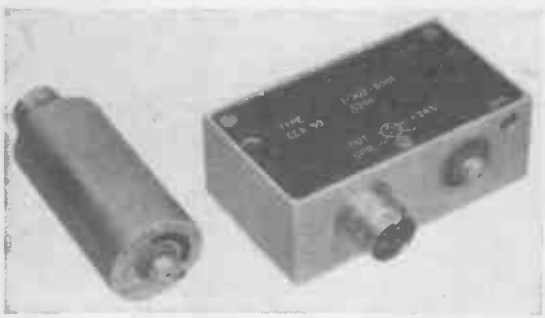
Small television camera made by EMI Electronics Ltd. for closed-circuit applications. The head amplifier for the camera is housed in the rear stainless-steel container.

Right: Universal counter-timer Type TM51C with a top counting frequency of 6 Mc/s (Levell Electronics Ltd.).

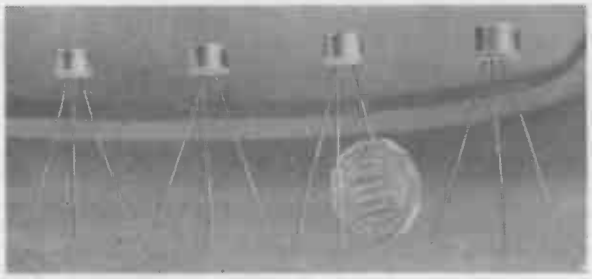


Heathkit Model IM-30U transistor tester from Daystrom Ltd.

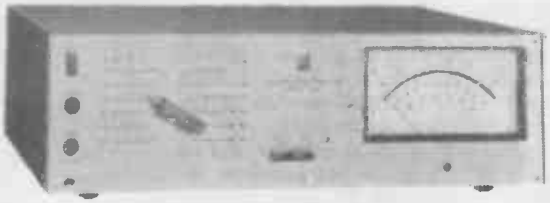
Right: Microtest Type 700 klystron power supply.



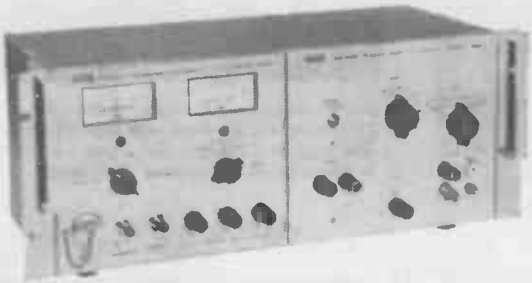
Left: Voltage amplifier and charge amplifier produced by Consolidated Electrodynamics for use with piezo-electric accelerometers.



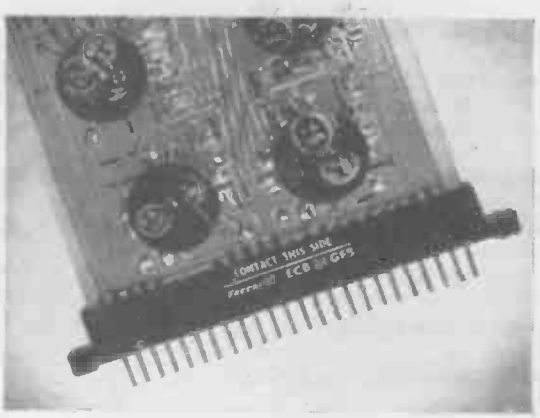
TVistor series of transistors Mullard's have introduced especially for domestic television applications.



Model EMT 125 low-frequency millivoltmeter (Elektromesstechnik Wilhelm Franz KG).



Fluke Model 540B thermal transfer standard. Thermal reversal error is less than 0.01% of input.



Twenty-four contact printed circuit board edge connector (Ferranti Ltd.).

series: AF186, an amplifier and self-oscillating mixer for u.h.f. tuners; AF180, an amplifier for v.h.f. tuners; AF178 a mixer/oscillator for v.h.f. tuners; AF181 and AF179, which are both vision i.f. amplifiers.

The AF186 is an alloy-diffused transistor and can be controlled with forward a.g.c. to give improved signal-handling whilst retaining a low voltage standing wave ratio at the aerial input. The AF178 and AF180 are germanium alloy-diffused transistors and a typical noise figure of 5 dB and a gain figure of 18 dB is quoted for the AF180 which, incidentally has a control range with attenuation of 40 dB. The remaining two transistors, the AF179 and AF181 provide power gains of 75 to 80 dB in typical i.f. stages. The AF181 is primarily intended for use in the first stage of i.f. amplifiers (or as a second stage in a three-stage unit) where adequate gain control is necessary if maximum signal-to-noise ratio is to be achieved. Hence the AF181 has a large control range—greater than 50 dB. The companion transistor, the AF179 is particularly suitable as an output device as it is able to maintain a constant gain at high current levels and has high dissipation characteristics. It also features low bottoming (voltage) at high frequencies.

A line-output transistor designated AU103 and a silicon efficiency diode BY118—both intended for use in conjunction with the A28-13W eleven-inch television picture tube—have been developed by Mullard's for portable television applications. The transistor has a collector-emitter voltage rating of 155 volts and a collector current rating of 10 A with fast turn-off characteristics. Fast switching is also claimed for the diode which has a reverse voltage rating of 300 V and a current rating of 14 A.

Mullard's have also recently produced a new r.f. transistor which they claim will make possible a reduction in the number of i.f. stages in a.m. and f.m. receivers. This silicon epitaxial planar device, designated BF115, is suitable for use up to 100 Mc/s—noise level at this frequency is about 3.6 dB—and has a high forward gain coupled with a low value of feed-back capacitance. A figure of not greater than 0.7 pF is quoted for a collector-to-emitter voltage of 10 V. Other features of this device include good a.g.c. performance, high resistance to voltage surges, a V_{CEO} rating of 50 V and a knee voltage of less than 1 V at 10 mA.

5WW 313 for further details

Low-frequency Millivoltmeter

A NEW high-stability millivoltmeter that can also be used as a laboratory measurement amplifier is announced by the German manufacturers Elektromesstechnik Wilhelm Franz KG, whose address is 763 Lahr/Schwarzwald, Kaiserstrasse 80. Designated EMT 125, it covers 1 mV to 300 V (f.s.d.) in twelve ranges and has an input impedance of 1 MΩ. The output impedance in the amplifier mode is 4 Ω.

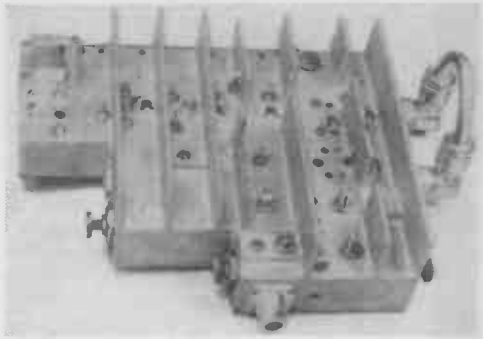
Transistors are used throughout the EMT 125, which conforms to the DIN 45 402 specification. The instrument is fully protected against accidental overloading and bursts of h.f. The upper cut-off frequency of the EMT 125 is 200 kc/s but, by switching, this may be reduced to 20 kc/s.

5WW 314 for further details

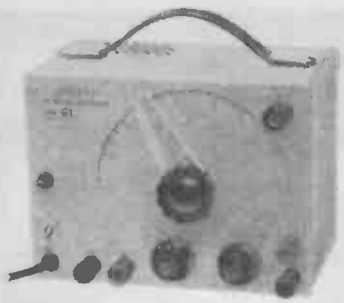
A.C./D.C. Comparator

AN instrument for accurate a.c. voltage and current measurement using thermal transfer techniques is being made by the John Fluke Manufacturing Co. Inc. Called the Model 540B thermal transfer standard, it has fourteen voltage ranges covering 0.25 to 1,000 V r.m.s., with a frequency range of 5 c/s to 50 kc/s and an input impedance of 182 ohms/volt of input.

Without the use of calibration curves or correction tables, the basic a.c. to d.c. transfer accuracy is ±0.01%. The transfer is achieved by means of a specially constructed vacuum thermocouple which, incidentally, is protected against overload. Each input range may be used

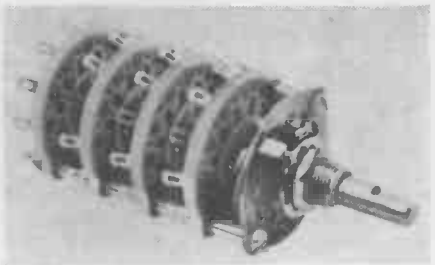


Five-watt transistor local oscillator unit designed to operate at 2Gc/s. This unit is part of the new G.E.C. range of transistor microwave communications equipment.



Low frequency signal generator introduced by Linstead Electronics Ltd.

Heathkit reflected power meter and v.s.w.r. bridge Type HM-11U.



One of the Moduline series of rotary switches offered by Diamond H Controls Ltd.

to measure voltages from ½ to 1 times the range setting; maximum galvanometer resolution varies between 0.0012% of input per scale division at 1 times to 0.006% of input per scale division at ½ of range setting.

A series of thirteen shunts are available for the 540B and allow precision current measurements from 2.5 mA to 10 A a.c. The basic accuracy is ±0.03% and the frequency range is from 5 c/s to 100 kc/s.

Nine high-frequency thermal convertors are also available for the 540B and extend the frequency range of the instrument to 50 Mc/s. One is provided for each voltage range from 0.5 to 50 V and may be used at ½ to 1 times the rated voltage.

This instrument is available in the United Kingdom through Livingston Laboratories Ltd., of 31 Camden Road, London, N.W.1.

5WW 315 for further details

Printed Circuit Board Edge Connectors

A SELECTION of single- and double-sided printed circuit board edge connectors is available from Ferranti Ltd., of Kings Cross Road, Dundee. Contact sizes range from 8 to 40 in multiples of 8. The spacing between contacts is 0·150 in and the d.c. working voltage is 450 V. The current capacity of each pole is one amp.

Polarizing keys are provided which may be inserted into any of the pole positions without removal of, or damage to, the contact concerned. The contacts are of phosphor bronze and the actual contact area is gold-plated to a depth of 0·0002 in.

5WW 316 for further details

Low-frequency Signal Generator

COVERING the frequency range 10 c/s to 100 kc/s in four switched ranges is the Model G1 generator from Linstead Electronics Ltd., of 35c Newington Green, London, N.16. This unit, which operates from the mains, provides up to 6 V r.m.s. sine wave output, up to 9 V p-to-p square wave output, and up to one watt at three ohms over the frequency range 50 c/s to 20 kc/s. The G1 measures 8¼ × 6½ × 6 in, weighs 7½ lb and costs £20.

5WW 317 for further details

Transistor Microwave Equipment

MICROWAVE communications equipment using transistors throughout is being manufactured by G.E.C. (Telecommunications) Ltd., of Coventry. So far G.E.C. have two units in production, one suitable for main trunk routes and will carry 960 speech circuits—or a television channel—in the frequency bands 1.7 to 1.9 Gc/s and 1.9 to 2.3 Gc/s. Auxiliary equipment for this two-watt link has also been transistorized.

A capacity of 300 speech channels is provided by the second unit, which operates between 7.4 and 7.7 Gc/s. This equipment is suitable for spur applications and a feature is that any part of the baseband may be dropped and reinserted at any repeater station without demodulation of through circuits.

5WW 318 for further details

Rotary Switches

MODULAR rotary switches introduced in the United States a few months ago by the Oak Electro/netics Corporation, are now being made-up by the British subsidiary Diamond H Controls Ltd. This series of switches, designated Moduline, gives the design engineer a wide range of variables, as follows: 6 different switch sizes; 101 different sections; choice of up to 24 positions; 6 different shaft ends; 24 options of flat angle; 1 choice of bushing; 2 locating key positions; 383 variations of the complete assembly; 5 choices of detent angle, depending on the type of switch; and 24 different shaft lengths.

The address of Diamond H Controls Ltd. is Vulcan Road, Norwich, NOR 85 N.

5WW 319 for further details

Reflected Power Meter & V.S.W.R. Bridge

AN inexpensive instrument that can be used to indicate percentage forward and reflected power, and voltage standing wave ratio is announced by Daystrom Ltd., of Gloucester, in the form of the Heathkit Model HM-11U. Although designed primarily for use with amateur radio transmitters, this instrument has an r.f. power handling capability of 1 kW and may be suitable for some commercial applications. The input and output impedance of the Model HM-11U is 75 Ω and the band coverage is from 160 to 2 metres (2 to 150 Mc/s). Insertion loss from 160 to 10 metres is less than 1% and less than 10% up to 2 metres.

This instrument measures 4⅜ × 7¾ × 4$\frac{1}{16}$ and weighs 2½ lb. Assembled, the price of the Model HM-11U is £10 10s 0d and in kit form it costs £8 5s 0d.

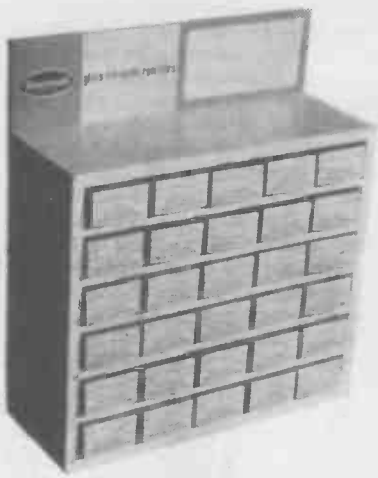
5WW 320 for further details

High-power S.S.B. Tetrode

ABLE to develop a load power of 1 kW, the new Mullard YL1230 tetrode utilizes

Mullard YL1230 metal-ceramic tetrode for s.s.b. applications at frequencies up to 200 Mc/s.

S.T.C. Type 74251 millivoltmeter introduced for general purpose and telecommunications use.



Metal oxide resistor kit from Electrosil Ltd.

metal-ceramic techniques to ensure optimum stability, high gain and low distortion, and is suitable for single sideband applications. At 1 kW output level −40 dB can be achieved without the use of r.f. feedback.

Typical s.s.b. operating conditions for the YL1230, which is suitable for use at frequencies up to 200 Mc/s, are as follows: Va 2.5 kV; Vg_2 250 V; $-V_{g_1}$ −50 V; Ia 600 mA; and p-e-p output of 1.2 kW.

5WW 321 for further details

Metal Oxide Resistor Kit

A METAL oxide resistor kit containing thirty values of resistor, each with three ratings (general purpose, high-stability and semi-precision) has been introduced by Electrosil Ltd., of Pallion, Sunderland, Co. Durham. The kit is housed in a cabinet measuring 14×12×5 in and normally covers the E6 range of preferred values, but special combinations of resistance values can be supplied to order. The resistors are qualification approved to DEF 5114A and have Post Office approval to D.2228A. Stability of all resistors is 0.5% at semi-precision rating, 1% at high-stability rating, and 2% at general purpose rating. Standard tolerances are 5%, 2% and 1%.

5WW 322 for further details

Differential Amplifier Transistors

TWO isolated high-gain, low-noise silicon planar transistors housed in a micro-miniature encapsulation about 150 times smaller than a TO-5 transistor can are being manufactured by the National Semiconductor Corporation. The two transistors in the block, designated NS7070, have a d.c. beta of 100 and are matched to within ±10%; the base-emitter voltages differ by less than 5 mV. The change in base-emitter voltage differential with temperature is 10 μV per degree Centigrade from −55 to +125°C, when the collector voltage is 5 V and current is 10 μA. Connections to the block, which measures 0.080×0.065×0.065 in, are by 0.005 in wires that can be soldered or welded.

These silicon blocks are handled in the United Kingdom by Walmore Electronics Ltd., of 11-15 Betterton Street, Drury Lane, London, W.C.2.

5WW 323 for further details

Millivoltmeter

A NEW general purpose a.c. millivoltmeter, covering 0-1 mV, 0-3 mV up to 30 V f.s.d. in ten ranges, is announced by the Transmission Testing Apparatus Division of Standard Telephones and Cables Ltd., Corporation Road, Newport, Mon. An active probe is employed with the new 74251 millivoltmeter, making it suitable for use in the frequency range 20 c/s to 20 Mc/s. Input impedance is greater than 100 kΩ in parallel with 40 pF.

An easy-to-read meter display containing two r.m.s. voltage scales and a decibel scale for use with 75-ohm circuits is provided and all the switching functions, including range, are by push-button. This portable, transistorized instrument may also be used as a bridge detector, and its calibrating oscillator can be used to supply approximately 100 kc/s at 300 mA for external use. The internal amplifer may also be used for external applications.

5WW 324 for further details

Tunable Magnetrons for Frequency Diversity Radar

TWO tunable magnetrons designed to provide the controlled frequency jumping required by diversity radar systems are announced by Mullard Ltd. These magnetrons, which have been designated JPS9-80 and JPS9-200, operate in the frequency range 8.5 to 9.5 Gc/s and are tuned by a high-speed spinning tuner mounted in a specially designed resonant cavity. This provides a "fail-safe" arc-free type of tuning and is driven by a simple servo-motor. The system covers 450 Mc/s in 500 μsec in a quasi-sinusoidal manner.

This type of drive which utilizes the fringe fields of the magnetron magnet is said to avoid the inherent life limitations of the slower, hydraulic systems and the life of the units is dependent only on the cathode life—as with fixed frequency magnetrons. They are also considerably smaller than the hydraulically tuned magnetrons or the high-power klystrons of the type normally used in the local oscillator power amplifier chain of a radar system. They are in fact only slightly larger than the fixed frequency types. The smaller of the two, the JPS9-80, weighs 8 lb and has a minimum output power rating of 70 kW, while the other weighs 15 lb and is rated at 200 kW.

These spin-tuned magnetrons may be used at fixed or programmed pulse repetition rates with a variation in output frequency, or at fixed or programmed frequencies with a variation in repetition rate. The smaller of the two is now in production and development samples of the JPS9-200 are available.

5WW 325 for further details

Airmec

The upper limit of the frequency range of the Airmec Type 298 counter advertised on page 77 of our April issue is 100 Mc/s, not 50, as stated in error.

WORLD OF WIRELESS

Colour Television Deadlock

THERE now seems little likelihood of an internationally agreed standard for colour television. The two-week meeting in Vienna of the C.C.I.R. television study group, which was attended by some 200 delegates from 45 countries, ended with a majority vote for SECAM (22) with PAL second (11) and N.T.S.C. third (6). It now remains to be seen whether any countries will introduce a service using the system of their choice, although the C.C.I.R. statement at the conclusion of the meeting said efforts to secure agreement on a single system must continue and the subject will be examined again at its plenary assembly in Oslo in 1966.

The countries voting for the three systems were:—

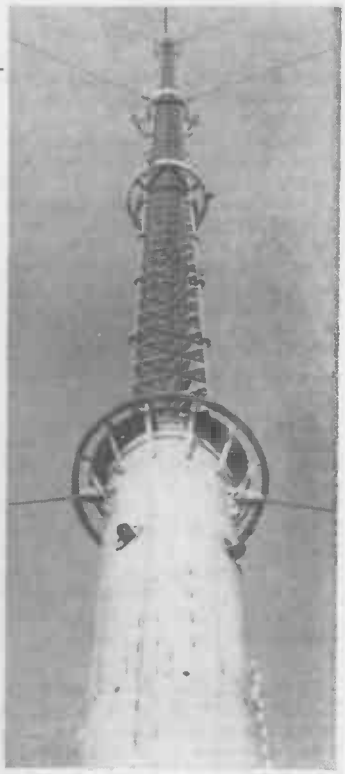
SECAM:—Algeria, Argentina, Bulgaria, Byelorussia, Cameroon, Czechoslovakia, France, Gabon, Greece, Hungary, Luxembourg, Mali, Monaco, Morocco, Niger, Poland, Rumania, Spain, Tunisia, Ukraine, Upper Volta and U.S.S.R.

PAL:—Austria, Denmark, Finland, Iceland, Ireland, Italy, New Zealand, Norway, Sweden, Switzerland and West Germany.

N.T.S.C.:—Brazil, Canada, Japan, Netherlands, U.K. and U.S.A.

Six countries abstained:—Australia, Belgium, Pakistan, South Africa, Turkey and Yugoslavia.

With no decision made at Vienna, there is opportunity for further evaluation of existing and new systems (see, for example, p. 210). A statement by the Postmaster General that the implications of Vienna must be fully considered before a date can be fixed for introducing colour in Britain suggests that the U.K. is not necessarily committed to N.T.S.C. Within days of the end of the conference the Television Advisory Committee met to discuss the situation. Engineering thinking within the I.T.A. and the programme companies, now appears to be favouring PAL.



Cylindrical steel mast *at Winter Hill, near Bolton, Lancs, which will carry the aerials for both the B.B.C. and I.T.A. transmitters. It is 1,015ft tall. The lattice section (above 650ft) will support the aerials which will be enclosed in curved glass-fibre sheets thus keeping a cylindrical shape for the whole mast. The aerials are being supplied by E.M.I. Electronics and the mast by B.I. Callender's Construction Co. A similar mast, but 1,265ft tall, is being built at Emley Moor, Yorks.*

Component Industry's Balance of Trade

ALTHOUGH the overall 1964 import-export figures for the component industry given in the 32nd annual report of the Radio & Electronic Component Manufacturers' Federation show a credit balance (exports £58.7M, imports £24.2M) certain products show an adverse balance of trade. For example, the value of exported transistors and semiconductor devices is given at £2M (a 5% decrease on 1963) compared with imports of £5.3M (a 56% increase). Exports of valves, c.r. tubes and parts increased by only 3% to £9.6M, whereas imports went up by 27% to £7.6M. Capacitor and resistor exports totalled £3.2M although imports stood at £4.3M. It should be stressed however that neither the export nor import figures take account of components used in complete gear.

As in recent years, there were three main sources of component imports, the Netherlands (£3.2M), the U.S.A. (£3M) and West Germany (£2.4M), which together accounted for 77% of the world total. The principal markets for British components were South Africa (£2M), Sweden (£1.9M), India (£1.8M), Netherlands (£1.8M) and Finland (£1.7M).

The R.E.C.M.F. Report also refers to the plans made for the setting up of a European committee for co-operation between component manufacturers' associations in Belgium, France, W. Germany, Italy, the Netherlands and the U.K. The title chosen for the organization is the Committee of European Passive Electronics Component Manufacturers' Associations (C.E.P.E.C.).

Radio Astronomy: Fleck Committee Report

FOR just over three years the Radio Astronomy Planning Committee, set up by the Government under the chairmanship of Lord Fleck, has been considering the probable future developments in radio astronomy. The twelve-man committee* has been considering in particular the proposals for new and large radio telescopes for which Government aid is likely to be required, the best ways of providing and operating them and the question of international co-operation in the field of radio astronomy.

The committee's report has now been issued in which it pays tribute to the work of British radio astronomers, particularly the teams led by Hey at R.R.E., Lovell (Manchester) and Ryle (Cambridge), and recommends that "as a matter of policy for at least the next eight years, the U.K. should press forward with research in radio astronomy at the existing centres giving it generous treatment."

The committee draws attention to the danger of electrical and radio interference which could severely restrict the use of the existing and planned radio telescopes at Jodrell Bank, Cambridge and Malvern, and appeals for the continued co-operation of the appropriate planning authorities in safeguarding this work because they regard it as of national scientific moment.

*Sir Edward Appleton (Edinburgh University), Dr. D. G. Christopherson (Durham University), Dr. W. L. Francis (D.S.I.R.), Dr. J. S. Hey (R.R.E., Malvern), Prof. F. Hoyle (Cambridge University), Sir Willis Jackson (London University), Sir Ewart Jones (Oxford University), Sir Bernard Lovell (Manchester University), J. A. Ratcliffe (Radio Research Station), Prof. Martin Ryle (Cambridge University) and Sir Richard Woolley (Astronomer Royal).

Space Science Laboratory

HOLMBURY HOUSE, a Victorian mansion near Dorking, Surrey, has been purchased by University College, London, and will be equipped as an outstation of the Physics Department and be devoted to space science research. The purchase

has been made possible by a gift of £65,000 from the Mullard Company and the centre will be known as the Mullard Space Science Laboratory. It will be headed by Professor R. L. Boyd who will initially have a staff of 50 when the laboratory is opened at the beginning of the next academic year (October).

Scientists at the Laboratory will be engaged both on the planning and design of experiments using instruments to be carried in satellites or rockets, and on the subsequent analysis of information received from these flights, together with related laboratory studies. The teams research programme for the next three years plans to utilize eight satellites—two from the European Space Research Organization (ESRO) and the remainder from America. It will also be employing a large number of high-altitude research rockets. One was recently launched (using a "Skylark" from Sardinia under ESRO auspices to investigate electron temperature in the ionosphere at altitudes between 90 and 170 km.

More BBC-2 Stations:—By the end of this year five more major BBC-2 stations will be brought into service, making seven in all. The locations, transmitter characteristics, and opening dates are: Wenvoe, Glam (channel 51, e.r.p. 500kW) opening Sept. 12th; Winter Hill, Lancs (62/500) Oct. 17th; Emley Moor, Yorks. (51/1000) Oct. 17th; Rowridge, I.o.W. (24/500) Nov. 14th; and Black Hill, Lanarks (46/500) Dec. 12th. The permanent 1000kW transmitter at Sutton Coldfield, Warks., on channel 40, will begin operating on October 4th. All these u.h.f. transmitters will use horizontal polarization.

Stereo Transmissions.—As a result of the extension of the B.B.C's Third Network Music Programme into the afternoons, the experimental pilot-tone stereophonic transmissions from Wrotham three afternoons a week have been discontinued. Instead, pilot-tone stereo items are being included as part of the Music Programme transmissions from Wrotham on 91.3 Mc/s and Swingate (Dover) on 92.4 Mc/s on Mondays from 2.30 to 3.0 p.m. and Thursdays from 11.0 to 11.30 a.m.

R.E.C.M.F. Council.—At the thirty-second annual general meeting of the Radio & Electronic Component Manufacturers' Federation on April 6th the following were elected to the council for 1965/6:— R. Arbib (Multicore Solders), E. E. Bivand (S.T.C.), S. H. Brewell (A. H. Hunt), N. Dundas Bryce (Belling & Lee), R. A. Bulgin (Bulgin & Co.), B. E. G. Harris (Bakelite), Dr. F. E. Jones (Mullard), Dr. G. A. V. Sowter (Telcon Metals) and J. Thomson (Morganite Resistors). At the first meeting of the council the following were co-opted:— K. Hughes (Rola Celeston), F. W. Irons (McMurdo Instrument), C. R. Jennings (Formica), E. Marland (T.C.C.), J. D. Sutton (Parmeko) and E. E. Webster (Plessey). The new chairman is S. H. Brewell.

Valve and Semiconductor Production.—Sales of British valves, tubes and semiconductor devices for 1964 show an increase of 16.9% over those for 1963, according to figures issued by the British Radio Valve Manufacturers' Association (B.V.A.) and the Electronic Valve and Semiconductor Manufacturers' Association (VASCA). The relative figures are:— valves and tubes £48.3M (£42.7M, 1963) and semiconductors £23.7M (£18.9M).

BEAMA.—The Kingsway and Ascot offices of the British Electrical and Allied Manufacturers' Association have been transferred to Leicester House, Leicester Street, London, W.C.2. (Tel.: GER 0678). This is now also the address of the Electrical & Electronic Manufacturers' Joint Education Board.

A.I.R.O., the Acoustical Investigation & Research Organisation, Ltd., is to hold open days at its new laboratories at Hemel Hempstead, Herts., on May 6th & 7th. Invitation tickets are obtainable from A.I.R.O., 42, Store Street, London, W.C.1.

Amateur Tribute to I.T.U.—To mark the centenary of the International Telecommunication Union on May 17th, and in recognition of the link between the International Amateur Radio Union and the I.T.U., the secretary of Region I of the I.A.R.U. (John Clarricoats) has been given permission by the G.P.O. to use the call GB3ITU instead of his own (G6CL) during May. Special QSL cards are being prepared to confirm contacts with GB3ITU which will operate in the 3.5, 7, 14, and 21 Mc/s bands and possibly the 28 Mc/s band. It is also hoped to put GB3ITU in operation during "The '65 Show" at Earls Court (Aug. 25-Sept. 4) and also during September when the I.T.U. Plenipotentiary Conference will be in session in Montreux, Switzerland.

R.T.E.B. Exam. Results.—Of the 688 entrants for the practical test for the 1964 Final Radio & Television Servicing Certificate of the Radio Trades Examination Board 462 passed (67% compared with 74% the previous year). A total of 1,646 entered for the intermediate exam. and 1,081 passed. There were only 19 entries for the Final Electronic Servicing Certificate and 14 passed. In the intermediate exam. 154 of the 215 entrants passed. All entrants had previously taken the written papers.

I.E.E. Structure.—A Control & Automation Division is to be formed by the I.E.E. and the title of the Science & General Division changed to the Science & Education Joint Board. This board will co-ordinate the activities of those professional groups within each of the three divisions (Control & Automation, Electronics and power) that deal with basic science and education.

The fifteenth International Apprentice Competition is to be held, for the first time in the U.K., from July 18th-31st. Approximately 240 apprentices from Western Europe and Japan will be competing in practical tests in 25 different trades in Glasgow. The City & Guilds of London Institute is responsible for the selection of the British team which is picked (one representative for each trade) from about 1,100 nominations by employers.

Electron Beam Machining.— *At the Mullard Research Laboratories, at Salfords, Surrey, an experimental unit has been built for machining all types of materials—even diamonds—to a very high degree of accuracy, using an electron beam.*

I.T.U. Centenary:— *One of the two stamps being issued by the Post Office on May 17th to mark the centenary of the International Telecommunication Union.*

An international **Aerospace Instrumentation Symposium** will be held at the College of Aeronautics, Cranfield, Beds., from March 21st to 24th next year. It is being sponsored by the College and the Aerospace Division of the Instrument Society of America. Further details are available from M. A. Perry at the College.

A week's **full-time** lecture/laboratory course on **transistor circuit design** is to be held at the Twickenham College of Technology, Egerton Road, Twickenham, Middx., from May 31st to June 4th. It is intended for graduates or holders of the H.N.C. in electrical engineering. (Fee, 9gn).

The U.K. Government proposes to increase **receiving licence** fees to £5 for a combined television-sound licence and 25s for sound only from August 1st. When announcing this in the House of Commons on April 14th the Postmaster General said that the whole question of broadcasting finance requires further study. This review will be completed as soon as possible and, the P.M.G. said, must be seen as part of the wider review of broadcasting policy which the Government is undertaking, including educational broadcasting, the allocation of a fourth television service and local broadcasting.

1966 Battery Symposium.—The **fifth international** symposium on batteries will be held in Brighton in September 1966. It is sponsored by the Joint Services Electrical Power Sources Committee which has now taken over the duties of the Inter-Departmental Committee on Batteries, organizers of the earlier symposia. Further information is obtainable from D. H. Collins (secretary of the Committee), Electrical Dept., Admiralty Engineering Laboratory, West Drayton, Middlesex

PERSONALITIES

Sir Lawrence Bragg, O.B.E., M.C., M.A., D.Sc., F.R.S., is retiring from the directorship of the Royal Institution at the end of August and will be succeeded **by Professor George Porter, M.A., Sc.D., F.R.S.** Sir Lawrence, who is a Nobel Laureate, gave up his post of Cavendish Professor of Physics at Cambridge in 1954 in order to take over the direction of the Royal Institution. Professor Porter, who is 44 and is at present Firth Professor of Chemistry in the University of Sheffield, recently gave a series of television lectures on "The Laws of Disorder." Since it was founded in 1799 the Royal Institution has been directed by a resident professor for whom it has provided accommodation at its headquarters in Albemarle Street, London, W.1.

S. R. Mullard, M.B.E., M.I.E.E., founder in 1920 of the Mullard Radio Valve Company, has received the honorary insignia award in technology of the City & Guilds of London Institute (C.G.I.A.). Mr. Mullard, who is 81, retired from the managing directorship of the company in 1929 but remained a director of Mullard Ltd., and its associate companies. During the 1914/18 war, he designed and constructed radio valves for the Services, and later, in collaboration with the staff of H.M. Signal School, Portsmouth, invented and developed high-power transmitting valves in fused silica bulbs.

W. R. Thomas, B.Sc., M.I.E.E., has been appointed group chief scientist of Elliott-Automation. He joined Elliott Bros. in 1952 as general manager and has been a director of Elliott Space and Weapon Automation Ltd. since 1963. Mr. Thomas, who graduated at the University of Wales, Aberystwyth, was technical officer in the Radio Dept., at R.A.E., Farnborough, throughout the war, after which he spent six years in the Guided Weapons Dept.

Group Captain E. Fennessy, C.B.E., B.Sc., M.I.E.E., who, as annnounced last month, resigned from the managing directorship of Decca Radar and joined the Plessey company, has been appointed chief executive of the new

Gp. Capt. E. Fennessy

Electronics Group of the company. Group Captain Fennessy, who is 53, served on the staff of No. 60 (Radar) Group, R.A.F., for the major part of the war having previously been with the original Air Ministry radar research team at Bawdsey Manor from 1938. He had been with Decca since 1945. **E. E. Webster, M.I.E.R.E.,** has become chief executive of Plessey's new Components Group. Mr. Webster, who is 56, joined Plessey in 1950 as chief inspector of the Swindon Region of which he became general manager in 1961 and director a year later. He started his career with Marconi Marine and was later with S.T.C. Throughout the war he was in the Air and Supply Ministries, after which he was, for three years, with Fleming Radio as general manager. Other chief executives appointed under the Plessey reorganization are **F. Limb, O.B.E.** (Telecommunications Group), **H. E. C. Nash** (Automation Group), and **D. R. Trowbridge** (Dynamics Group). Mr. Limb, who is 66, is managing director of Ericsson Telephones which he joined 40 years ago as an engineer. Mr. Nash (41) who had been a director of Elliott Processing joined Plessey in January. Mr. Trowbridge (44) joined Plessey in 1939 and has been general manager of the Aircraft Equipment Group since 1962. Plessey also announce the appointment of **G. H. Doust** as chief executive of the Plessey organization in Australia. Mr. Doust, who is 49, joined Plessey in 1956 and has been managing director of Plessey International Ltd.

E. E. Webster

F. J. M. Laver, B.Sc., M.I.E.E., who joined the Post Office in 1935, at the age of 20, and was employed at the Research Station at Dollis Hill, working at first on radio-frequency measurements and the development of the quartz crystal clock, has been appointed an assistant e.-in-c. In 1951 he was posted to the Radio Planning Branch and dealt with international radio questions and since early 1963 he has been assistant secretary in charge of the Office Machines Branch of the Treasury Management Services. He graduated in logic and mathematics as an external student of London University.

J. E. Flood, D.Sc., Ph.D., M.I.E.E., chief engineer in the Advanced Development Laboratories of A.E.I's Telecommunications Division, has been appointed professor of electrical engineering at the College of Advanced Technology, Birmingham, which is to become the University of Aston. Dr. Flood, who is a graduate of Queen Mary College, University of London, has been closely associated with the development of electronic telephone exchanges and has served on the Electronic Research Committee of the G.P.O. and telephone manufacturers.

G. R. Scott-Farnie, C.B.E., M.I.E.R.E., managing director of International Aeradio Ltd. since 1958, has also been appointed deputy chairman to the new chairman, **Keith Granville,** C.B.E. Mr. Scott-Farnie joined I.A.L. as operations manager in 1947 shortly after the formation of the company. For

G. R. Scott-Farnie

the major part of the war he was on special signals duties in the R.A.F. and from 1944-45 was signals intelligence officer on General Eisenhower's staff. He operates an amateur radio station under the call G5FI.

David Ashworth has joined d-mac ltd., of Glasgow, as applications engineer. Mr. Ashworth, who is 27, was previously with I.C.T. Ltd., Stevenage, working on computer developments.

J. H. D. Ridley, M.B.E., head of the Engineering Secretariat of the B.B.C. since 1950, has retired. He was in the radio industry from 1920 until he joined the corporation in 1938. From 1923 to 1932 he was with Burndept Wireless, latterly as chief engineer, after which he joined Edison Swan Electric Co. as chief radio engineer. Mr. Ridley has spent the major part of his 27 years with the B.B.C. in the Engineering Secretariat. He is succeeded by **J. A. Fitzgerald,** A.M.I.E.E., who joined the B.B.C. in 1940 as a maintenance engineer. In 1949 he transferred to the Engineering Secretariat where he was responsible for patent work. He was also secretary of the B.B.C's Engineering Advisory Committee.

Hugh Menown, M.Sc., has been appointed manager in charge of the Gas Tube Division at the Chelmsford factory of the English Electric Valve Company. Mr. Menown graduated in experimental physics at Queen's University, Belfast, and joined the English Electric Valve Company in 1951, as an engineer working on gas tubes. He has been engaged on the development and production of hydrogen thyratrons, and for the past three years has been assistant manager of the division of which he is now in charge.

T. G. Clark, A.M.I.E.R.E., who had been with Decca Radar since 1951, has joined the Plessey Group. For the past three-and-a-half years he was a group leader in the Radar Development Laboratories, Chessington, Surrey, concerned with both marine and special developments. Before joining Decca he was in R.E.M.E. as a warrant officer working on radar and telecommunications equipment.

J. Hale, B.Sc. (Eng.), A.M.I.E.E., production manager of Feedback Ltd., which he joined about a year ago, and **E. G. Bell,** A.M.I.E.E., the company's sales manager for the past two years, have been appointed to the board of directors. Mr. Hale was a student apprentice with A.E.I., then served as an electrical officer in the R.N.V.R. He was for four years with Production Engineering Ltd. before joining Feedback. Mr. Bell was a development engineer with Salford Electrical Instruments before joining Muirhead & Co. in 1954. He went to Servomex Controls in 1958 where he stayed until joining Feedback in 1963.

S. D. Coombs has joined Keyswitch Relays Ltd., as chief development engineer. He comes to Keyswitch from Standard Telephones and Cables where he was general applications engineer, concerned with relays and associated equipment. Prior to this, Mr. Coombs was with de Havilland Propellers Ltd., on the Blue Streak project, and was earlier with Elliott Bros.

Sydney S. Bird, who in 1920 founded the well-known company bearing his name, celebrated his 80th birthday at the end of March. To mark the occasion the directors of the parent company Astaron-Bird Ltd. arranged a banquet

Sydney S. Bird

at Ferndown, Dorset. Gifts were presented to Mr. Bird by the directors and staff and, on behalf of over 80 friends in the radio and electronics industry, H. J. Barton-Chapple gave him a camera.

E. G. Lennard has resigned from the position of commercial director of Cosmocord which he joined 6½ years ago. He has represented the company on the council of the Radio & Electronic Component Manufacturers' Federation for several years and has served on its Export-Import Committee.

Eric J. Gargini, A.M.I.E.E., A.M.I.E.R.E., author of the article on page 210 in this issue, is colour television section leader at the laboratories of Rediffusion Research Ltd. He received his technical training at Southall Technical College and, after a short period as a trainee with E.M.I. and then Philco, he served in the R.A.F. throughout the war. He rejoined E.M.I. in 1945 where he was concerned with wire television distribution systems and later colour television receiver development. He left E.M.I. in 1960 to go to Marconi's at Chelmsford and six months later joined the Rediffusion organization.

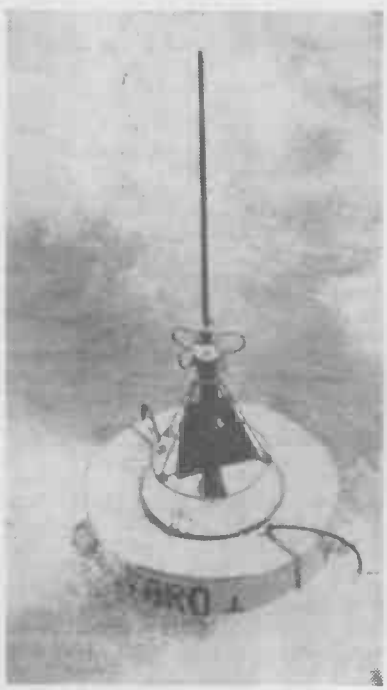
Squadron Leader H. C. Jamieson and **Senior Technician G. W. Honey** have each been awarded £75 by the Air Force Board for a modification to the approach radar installation at R.A.F. Wyton, Hunts, which was regarded as a valuable contribution to flight safety. Their device enabled a flatter angle of approach, as assumed by an aircraft suffering from wing flap failure, to be more positively indicated on the face of the radar tube thereby reducing the possibility of human error by controllers.

NEWS FROM INDUSTRY

Plessey Reorganization.—The Plessey Company's operations in the U.K. are being reorganized and all its subsidiaries will operate under the name Plessey within five groups, these being: Automation, Components, Dynamics, Electronics and Telecommunications. Commenting on this Lord Kilmuir, Plessey's chairman said eventually all products will be marketed under the single name Plessey, although a number of traditional trademarks will be retained. Changes are also being made in the overseas organization.

Eddystone Radio Ltd.—The English Electric Company have agreed to purchase from Laughton & Sons Ltd. the whole of the issued capital of the latter's subsidiary Stratton & Co. Ltd., the manufacturers of Eddystone communications receivers. The purchase price was 220,000 English Electric £1 Ordinary Shares plus £104,157 in cash. It is the intention of the English Electric Co. to change the name of Stratton to Eddystone Radio Ltd. and operate it as a subsidiary of the Marconi Company, a member of the English Electric Group.

Oceanographic Equipment.— *To assist in the collection of information in oceanograpic surveys, EMI-Cossor Electronics Ltd., of Canada, have produced a device for gathering underwater data for recording or relaying to a monitoring station, ship or aircraft. The device consists of a sub-surface float containing measuring equipment (for water-speed, salinity and temperature tests) moored to the bottom by a taut wire and connected to a surface-buoy which houses the recording and radio equipment.*



SGS-Fairchild European Expansion.—The SGS-Fairchild organization announced in London recently that the group is expanding its activities and is now able to supply silicon planar semiconductor devices for all types of electronic equipment. Under the title "Total Planar" the group is now producing and marketing comprehensive ranges of semiconductor devices, including microcircuits, for the military, professional, industrial and consumer markets. To cope with the expansion, it is planned to increase the output of the Ruislip plant—one of the two European manufacturing plants, the other being in Milan—by four times to about ten million units a year, and also to build a new factory in Sweden. SGS-Fairchild also plan to establish research and development laboratories in Europe. Information from the American Fairchild research laboratories will be available to the staff of the proposed European laboratories and in preparation for their opening, a number of SGS-Fairchild engineers are at the Californian laboratories of Fairchild Semiconductors "injecting the European point of view."

Long Term Planning.—Industrial Market Research Ltd., of 34 Sackville Street, London, W.1, have been appointed U.K. representatives and consultants for the long term planning service run by the Stanford Research Institute, which was founded in 1946 by the Trustees of Stanford University and a group of American businessmen. This service is to draw management attention to new business possibilities and new competitive threats and also give the implications of development in technology. More than half of the 2,700 staff are technical and professional personnel and recent reports cover a variety of subjects including electrical test equipment and new semiconductors.

Mullard Research Laboratories.—A further three-storey wing is to be built on to the laboratory block recently completed at the Mullard Research Laboratories near Redhill, Surrey. Work has commenced and will take about a year to complete providing an extra 35,000 sq ft of space.

Texas Instruments Incorporated, of Dallas, have received a contract valued at $5,604,937 from the U.S. Naval Oceanographic Office for a marine geophysical survey. This is one of the largest contracts of its type to be placed with an industrial concern and will be carried out over the broad areas of the eastern and central Atlantic Ocean, and the Mediterranean. Information during the survey, which is planned to take three years, will be collected with seismic and oceanographic instruments installed on two specially fitted vessels now being completed in an American shipyard.

Pantiya Electronics Ltd., which was formed nearly ten years ago when the old Pantiya Tea and Rubber Company ceased to trade, is to go public. In 1956 Pantiya acquired the whole of the issued share capital of Walmore Electronics Ltd., for £100,000 in cash, and last November acquired the issued capital of Marlyne Electronics Ltd. and its subsidiaries for £300,000. Marlyne Electronics manufacture, import, wholesale and retail radio and audio equipment and components for the home constructor; one of their outlets being Stern-Clyne Ltd., who operate twelve shops in London and the provinces. A recently formed subsidiary of Pantiya, Saba Electronics Ltd., now has the sole U.K. concession for the products of Saba, the West German radio, television and audio manufacturers. The combined pre-tax profits of the Pantiya Group and Marlyne Group have increased from £6,500 in 1954-55 to £139,000 in 1963-64.

Associated Electrical Industries Ltd. trading profit for 1964 was up by over £5.25M on the previous year's result at £13.9M. In the year under review, £5.3M was set aside for taxation as against £2.7M in 1963, leaving a net profit of £6.2M, which represents an increase of £2.3M. In a circulated statement to shareholders (65th a.g.m. on 28th April) the company's chairman, Mr. C. R. Wheeler, made reference to an improvement in the profit of the Electronics Group, which comprises the Electronics Apparatus Division, the Instruments Division and AEI Automation.

British Insulated Callender's Cables group sales for 1964 amounted to £216M and showed an increase of £32M on the 1963 figure. Pre-tax profits were up by just over £3M at £15.86M and after providing for taxation and other deductions, the net profit totalled £8,171,000, compared with £6,820,000 in the previous year.

The Amplivox Group, which became public last June, announce a pre-tax profit of £202,748 for 1964, an increase of £54,735 on the previous year's result. After tax, profits rose from £64,085 to £93,176.

N.S.F. Ltd. pre-tax profit for 1964 amounted to £360,000 and showed an increase of £49,526 on the previous year's result. Tax on these profits accounted for £194,000, compared with £163,000 for last year, leaving a net profit of £166,000 (£147,474). The thirty-third a.g.m. to be held on 5th May is the first as a public company.

Marconi Instr. Acquire W. H. Sanders.—Marconi Instruments Ltd. have acquired over 96% of the Preference Shares and over 84% of the Ordinary Shares of W. H. Sanders (Electronics) Ltd.

Painton Acquire Electroprints.—A majority shareholding in Electroprints Ltd., of Portsmouth, who manufacture printed wiring on flexible and rigid materials, has been acquired by Painton & Co. Ltd. Mr. C. M. Benham, Painton's chairman has been appointed chairman of Electroprints Ltd.

Plessey Bid for T.C.C.—The Plessey Company have made a bid, worth £3.6 M, for the Telegraph Condenser Company. The offer, which is subject to 90% acceptance, has been made after consultations with British Insulated Callender's Cables, who own about 65% of T.C.C. and intend to accept the bid. Financial details of T.C.C. apepared in last month's issue.

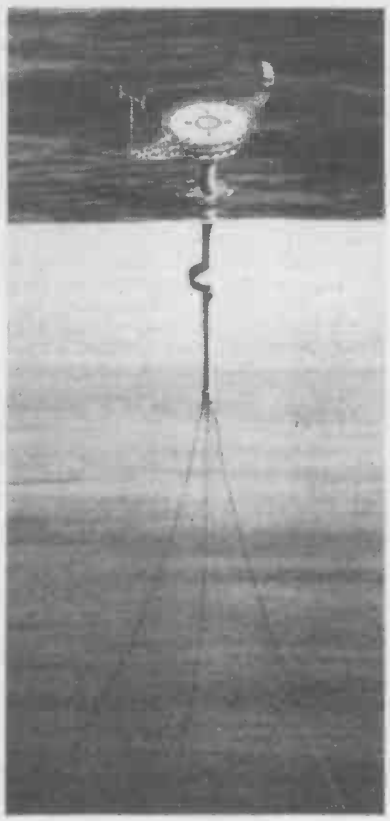
Goonhilly-Bristol Microwave Link.—Standard Telephones and Cables Ltd. have received a contract from the Post Office, worth about £300,000, for a high-capacity microwave link between Bristol, Plymouth and the communications satellite station at Goonhilly Down, Cornwall. This link, which will be the first in the U.K. to operate in the "upper 15,000 Mc/s band," will join the microwave system S.T.C. are now installing between Bristol and the London Post Office tower.

Hughes Expansion.—Hughes International (U.K.) Ltd., who at present are producing a million semiconductors a month at their Glenrothes, Fife, plant are soon to start making planar devices. In preparation for the production of these devices, the floor area has been increased by 13,500 sq ft. Initial production will be 300,000 per month. The company's sales department has moved from Hounslow to larger premises at Heathrow House, Bath Road, Cranford, Middx.

M.E.L. Automation.—While extensions to the company's main factory offices are being completed, the automation division of the M.E.L. Equipment Company has moved from Crawley to Stone Street, Waddon Factory Estate, Croydon, Surrey (Tel.: MUNicipal 4971). The division is expected to return to Crawley at the end of the year.

Floating Navigation Stations

PLAN FOR TRANSATLANTIC CHAIN



BECAUSE of the increasing amount of air traffic using the North Atlantic, a new company called Seastation Telecommunications Ltd., has been formed to investigate a scheme for the setting up of a series of "floating stations" to carry trans-oceanic telecommunications and navigational apparatus.

In collaboration with the Ministry of Aviation—who have awarded the company a design contract worth £60,000—work is being carried out on the feasibility of establishing a number of permanent floating navigation-cum-communication stations connected with each other and with shore by underwater cables.

The proposed floating station consists of a tubular structure—about 400 ft in length and 16 ft in diameter—floating vertically in the sea with the greater part of its length submerged. The upper part of the spar buoy, as it is called, supports a large superstructure that is well above the reach of the waves and provides accommodation for the equipment, for a crew of about twelve, for a helicopter landing deck and for aerial arrays. The station is moored by three cables to anchorages on the sea bed and as the motions of the sea decrease rapidly with distance below the surface, the length of the cylinder makes the station particularly stable in the roughest weather. From tests conducted with a scale-model in water tanks, calculations have been confirmed that for 95% of the time the half amplitude pitch or roll will not exceed half a degree and that vertical motion would not exceed six inches.

In addition to navigation aids such as medium-frequency beacons and d.m.e., and v.h.f./u.h.f. equipment for air traffic control purposes, primary and secondary radar could be provided if required, with the necesary display data being transmitted through the underwater cables to a.t.c. centres either side of the ocean.

The new company is jointly owned by Cammell Laird & Co., shipbuilders and engineers, who are, incidentally, responsible for the marine construction side of the Ministry of Aviation study, and Submarine Cables, which is owned by Associated Electrical Industries and British Insulated Callender's Cables, and is responsible for the communications side. The company's chairman, Dr. J. N. Aldington, has stated that the Ministry of Aviation design study is expected to be completed in five to six months time. He also said a single chain—comprising two to four stations—crossing the North Atlantic would cost approximately £10 M to £15 M to install with running costs of about £300,000 to £400,000 a year. Once the go-ahead is given, it would take two to three years to get a system operational.

These "seastations," Dr. Aldington said, could also be used for other purposes. One of these being to replace weather ships as they have several advantages such as a stationary platform that enables high altitude wind velocities to be more accurately measured, and a direct link—by underwater cable—that allows contact to be made under all adverse conditions. Another example given by Dr. Aldington was the use of "seastations" in underwater cable communication projects where intermediate shore stations in long-distance links are not practicable for technical or political reasons.

The stations are to be self-supporting and able to operate for months at a time. Power for the various communication and navigational equipment will be provided by diesel-oil generators.

Should the scheme be adopted by the British Government, Dr. Aldington stated that subscribers, such as airlines and shipping companies, would pay dues in the same way as they now do for "fixes" and other services from the weather stations.

50 Years of Public Address

A.P.A.E. INTERNATIONAL GOLDEN JUBILEE EXHIBITION

LAST year's A.P.A.E. exhibition was reported in *Wireless World* to be the most ambitious show presented by the Association of Public Address Engineers, and this year's exhibition has beaten last year's records in every respect. The rapidly expanding Association presented its 16th annual exhibition at the King's Head, Harrow-on-the-Hill, on March 17th and 18th and the occasion marked the 50th anniversary of the first application of electrical equipment to address the public. The event, which took place in San Francisco in 1915 under the guidance of Jensen and Pridham makes the p.a. industry older than wireless broadcasting, since no public broadcasts had been made at that time.

The opening ceremony was conducted by the Danish Chargé d'Affaires and the Scientific Attaché of the Danish Embassy in honour of their countryman Peter Jensen (the "father of the loudspeaker"). Shortly afterwards a two-way radio link with New York took place and the past 50 years of p.a. were recalled by engineers on both sides of the Atlantic. The discussion touched on the use of time delays to overcome problems due to reverberation time and frequency shifting in systems to prevent acoustic feedback. However at this interesting point, just as we were about to learn why these techniqes were not used more widely in Britain, the discussion was brought to a close.

B.B.C. Demonstration

An interesting demonstration by B.B.C. engineers was given on the studio control room equipment. The transistorized control console, which was B.B.C. designed and built, has quadrant mixers and also bass and treble controls on each microphone channel. But even these do not meet the demands of present-day entertainment and "presence" controls have been included also.

Live gun shots are notably unrealistic in studios and the B.B.C. use a simulator which gives a very impressive performance. A thyratron white noise generator is used with the high frequency end of the spectrum tailored (coloured?) and gated to give single or machine-gun shots; ricochets are provided by the generator and a multivibrator whose h.t. supply is run down.

Another item used by the B.B.C. was an acoustic table, which transmitted incident sound and thus avoided interference at the microphone.

Veteran P.A. Exhibition

A display of old p.a. equipment aroused much interest. One item dated back as far as 1894, but strictly speaking this was private—not public—address equipment. It was the "Electrophone" system, which used a carbon pencil transmitter disguised as a Bible for use in churches

Part of the veteran p.a. display. The amplifier used by Baird with his television system is shown just left of centre on the upper row. Some collected literature on p.a. is seen behind the equipment, including a number of pages of Wireless World.

connected via Post Office lines to subscribers' headsets. This was provided by the G.P.O. on their display of "50 years of telephones" which included a replica of Graham Bell's original telephone.

The first p.a. apparatus did not use amplifiers and some of the carbon button microphones used passed as much as 5A. Amplifiers were introduced around 1918; but a 3-valve line amplifier used during the war in 1915 was shown. The Western Electric amplifier used by Baird in his television system is illustrated in the photograph of the display. One of the microphones shown was used by King George V at the opening of the Empire Exhibition at Wembley in 1924 (Western Electric double button carbon) and another was the Beyer microphone used by Rommel to address German troops in the desert campaign. Much of the equipment on display was in working order and an old Marconi amplifier with microphone and horn loudspeaker were shown to be capable of feedback at least!

Much of the equipment on manufacturers' stands had been seen before and some of the more recent items are outlined below.

Microphones

Most of the new introductions are dynamic types with multi-impedance connections (low, 20-60Ω; medium, 200-300Ω; and high, 10kΩ and above), often with bass cut and on-off switches. The AKG types D119CS and D119ES have both switches and a front-to-back ratio of 15dB at 1 kc/s. The CS has an output impedance of 200Ω and the ES offers a choice of three impedances. The Beyer M610 (displayed by Fi-Cord) with cardioid polar diagram has both switches with low and medium impedance outputs and the omnidirectional lavallière (neckslung) type M110 is also dual impedance. Fi-Cord also introduced two of their own microphones, the 801 and the directional 901, with responses extending up to 18 kc/s.

A field effect transistor has been used in the head amplifier of the S.T.C. capacitor microphone (type 4126) and this is available with an omnidirectional or a cardioid pattern. Also new is the 4119 ribbon microphone. Reslosound have added a switch to their pencil microphone (type PD); and the Vitavox M100, offering four impedances, has now reached the production stage.

Loudspeakers took a relatively back seat this year although a new range, primarily intended for rental, was announced by Sound Coverage but are electrically similar to the previous range. Goodmans have introduced two small loudspeakers with inverted ceramic magnets and whilst these are not for p.a. work, they will meet a demand for lighter and more compact equipment in other fields. A 3-watt elliptical motor-cycle mounting loudspeaker (Home Office approved) was shown by Rola Celestion.

Amplifiers

The C.T.H. range of p.a. equipment has been augmented with the MA50 (50-watt) transistor amplifier. Their p.a. series of amplifiers were battery operated whereas this unit (and the MB15) is for battery or mains operation. In the event of a mains failure, the amplifier will continue to operate from the battery, this being recharged when the mains supply is resumed. The Grampian 650 amplifier is similar to their 50-watt type 600 but the number of microphone channels has been increased to four. A 100-watt amplifier with six inputs (M.C. 100/6) is added to the VOX range and the volume level meter also monitors circuit voltages. (Similarly with the M.C. 50/6.)

Modular amplifier units are becoming noticeably more popular. The Audix mixer (MXT/6) and mixer-amplifier can be made up with any combination of their units, which include a single-tone generator. The S.T.C. modular transistor units include 35 and 60 watt amplifiers (with 100 V line outputs), two microphone pre-amplifiers, a mixer, master gain-control unit and microphone and loudspeaker switching units. Reverberation units (pre-amplifiers and 20 W amplifiers) for increasing reverberation time at selected frequencies, form part of the system. The pre-amplifier works from a 30Ω microphone in a Helmholtz resonator, amplifying a bandwidth of a few c/s, with provision for phase adjustment.

Contrary to the current trend Reslosound introduce three valve amplifiers (15, 30 and 60 W) and with high and low impedance inputs.

Miscellaneous

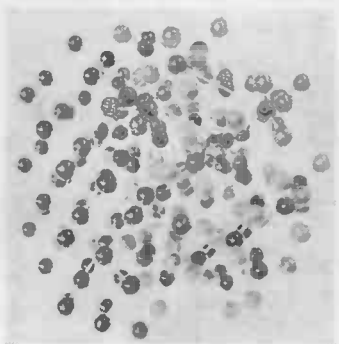
Radio microphones were seen on a number of stands. The transmitters are frequency modulated, often with speech compression and are, of course, crystal controlled, usually around 175 Mc/s according to allocation by the G.P.O. Lustraphone have introduced a combined microphone and transmitter with an output of 10 mW and using voice compression. The receivers are double superhets and on mains types a transmission indicator lamp is included. Magneta and Pamphonic market a Labgear radio microphone using speech compression and the receiver output may be used to feed into a telephone handset or a normal p.a. installation. The transmitter has a range of up to ½ mile under ideal conditions.

An Ultra tape recorder with a 32-track head for standard announcements of up to 6 minutes was seen on the Trix stand. Each track is selected by a push button and the machine can be used for 64 channel work with message lengths of 3 minutes.

3M have added two flat adhesive cables to their Scotchflex range; the 550 type, with two conductors, and the 800 type, with four conductors. Other cables on show included the EMT a.f. cables, shown by Bauch. One of the cables contains 10 pairs of individually screened wires and is reported to be anti-microphonic. The capacitance is about 70 pF per metre.

A transistor portable loudhailer (Bouyer Super Megaflex) was shown by Douglas Lyons Associates. The unit is rated at 7 watts and the rubber microphone is provided with a volume control.

THIS MONTH'S COVER



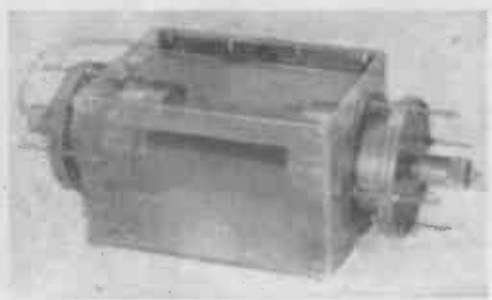
This atomic structure model represents an epitaxial arrangement of silicon on quartz. Work at the Allen Clark Research Centre of The Plessey Company aims to produce new types of integrated circuits in which single crystal films of semiconductor materials are deposited on insulating substrates. The purpose is to reduce capacitance coupling between neighbouring circuits.

PHYSICS EXHIBITION IN THE NORTH

THIS year The Institute of Physics and The Physical Society broke fresh ground by holding their exhibition—the 49th—in Manchester instead of London. Once again the scientific character of the event was maintained, by careful selection of items for their interest to physicists, and only about half of the offers were accepted for display. Last year's innovation, a special section devoted to educational exhibits, was repeated, and proved a popular feature with visitors.

RESEARCH

Non-linear acoustics.—It is often assumed in deriving a wave equation for acoustic waves travelling through a fluid medium that various parameters are independent of acoustic pressure, which results in a linear representation of the system. If waves of sufficiently high intensity are considered the system becomes non-linear, since density and bulk modulus are functions of acoustic pressure. Because of this non-linearity, two sinusoidal pressure waves will interact and give, amongst others, sum and difference frequencies. Birmingham University demonstrated the existence of the difference frequency by propagating pulsed pressure waves along the same



Formation of a virtual source of acoustic energy by exploiting the non-linear characteristics of a fluid. (Birmingham University.)

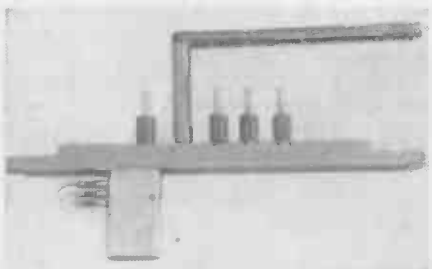
axis from two small barium titanate transducers immersed in water and at frequencies around 300 kc/s. In the region of interaction of the two waves a virtual source of directionally propagated audible pressure waves is thus formed. The elastic parameters are analogous to reactive parameters in electric systems, so parametric amplification and sub-harmonic generation may be possible in a similar fashion to electric systems. It is felt that this and similar exploitation of the non-linear effects may ultimately have application in sonar systems.

Protoplasm impedance is an unusual biological parameter being measured by Wayne Kerr to aid research into cancer and into new methods of food production. The effects of electric and magnetic fields on protoplasm and cell membranes are significant, and it is thought that more information may be obtained by a.c. impedance measurements than from the orthodox d.c. measurements, particularly as these living structures transmit electrical impulses by an electrochemical process similar to that of the animal nerve cell. A demonstration was given of measuring the dynamic response of the alga *Nitella* to electrical stimulation by an automatic balancing bridge. The real and imaginary components of the measured impedance (in this case R and C) were displayed on a chart recorder. Low-resistance metal electrodes cannot be used to make contact with the alga as they destroy the cell membrane, so extremely high-resistance glass electrodes are necessary. To avoid measurement ambiguities resulting from these high series resistances, the bridge is a transformer ratio-arm type with a split neutral terminal to permit the use of four electrodes instead of the usual two.

Sub-millimetre source.—Until recently, there have been no strong sources of radiation for laboratory use in the sub-millimetre wavelengths, that is between the short wavelength end of the microwave region and the long wavelength end of the infra-red region. The main difficulty has been finding molecules with suitable energy transitions, but a number are now known which will give stimulated emission in the region between 0.01mm and 1mm. S.E.R.L. have developed a tube using water vapour and emitting microsecond pulses of radiation at 0.0279mm. The N.P.L. demonstrated the Teratron (frequency about 1 teracycle per sec) which uses the CN radical in the form of acetonitrile vapour CH_3CN, and emits at 0.337mm. The acetonitrile vapour is pumped into a tube (about a metre long) and emission is triggered by an electric discharge which causes the molecule to decompose and give an excited CN radical. Since the CN is short lived, the pump is necessary to remove the decomposition products and replace the CH_3CN. The emission at 0.337mm occurs between two regions of strong absorption by water vapour; also, the wavelength is long enough to avoid scattering by most fogs, so there are possibilities for communication at this wavelength.

Reverberation.—A demonstration by the Physics Department of the Manchester College of Science and Technology illustrated the effect of increasing the reverberation time at mid-frequencies of the main theatre in the Renold building. This theatre had been designed for speech and had a reverberation time of 0.8 sec at mid-frequencies, but was found to be "dead" to performances of music. Increasing the reverberation time to 1.2 sec, with delays provided by a multi-head tape recorder and 37 loudspeakers, resulted in increased liveliness.

Cyclotron resonance.—Power dissipation problems in high frequency backward wave oscillators has prompted research into alternative methods of microwave generation. A device employing cyclotron resonance was shown by G.E.C., providing a source which was tunable over the whole of Q band. Interaction occurs between electrons moving in a cycloidal



New microwave vacuum tube, by G.E.C., using cyclotron resonance. The device is tunable over the whole of Q band by variation of the magnetic field in which the tube is inserted.

motion in perpendicular electric and magnetic fields and an r.f. wave from a local source. The r.f. wave propagates along a transmission line formed by the electrodes providing the electric field, and takes up energy from the electron beam so that the cycloid humps decrease in size. The output frequency is determined by the magnetic field which varies the cyclotron frequency of the electrons. The device has achieved a c.w. output of 11 watts with an efficiency of 5% and an anode voltage of 6 kV. It is expected that the tube will operate with up to 10 kV anode voltage and provide an output of 50 watts.

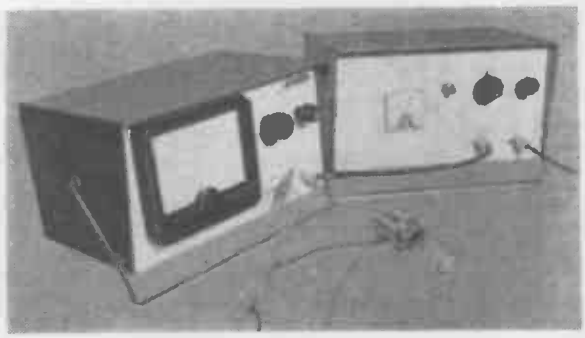
Thermionic generator.—In conjunction with Imperial College, Fairey Engineering Ltd. have been developing a thermionic energy converter for use with radioactive isotopes. The device shown was described as a gas-filled triode converter. Given a heat source, electrons are emitted from a cathode and collected at an anode as in a normal diode. The available power at the anode is limited by the space charge around the cathode and operation of the device depends on its neutralisation, enabling much larger powers to be drawn from the anode. In the device shown, a third electrode is used to cause a discharge in the inert gas which provides a source of ions to neutralize the electrons causing the space charge. The emitter is 90% tungsten with lanthanum and zirconium. The heat source in this experimental model is electrical, but the final source envisaged is a radioactive isotope, in particular a waste fission product available in quantity from nuclear reactors. The emitter has a work function of 2.4 V and is operated at 1,650°C, and the triode gives an output voltage of 0.7 V at a power density of 10 watt cm^{-2}. The power output achieved is in the region of 30-40 watts.

Semiconductor microwave generator based on the little-known Gunn effect was demonstrated by S.T.C. It consists of a 0.01in thick wafer of n-type gallium arsenide with contacts on each plane face, mounted in a coaxial circuit. When a potential of about 100 volts is applied across the contacts, the charge carriers form into domains which move across the material at the carrier drift velocity, producing current instabilities in the form of oscillations. The frequency of oscillation is determined by the transit time of the current carriers, and for a 50-micron wafer is about 6 Gc/s. To avoid excessive power dissipation in the crystal the applied voltage was pulsed, and on an oscilloscope the resulting microwave signals were shown superimposed on the square waves. Several watts of r.f. power can be obtained with this pulsed operation and the efficiency of conversion of d.c. to microwave energy is of the order of 5%. This direct method of generating microwave signals may prove much simpler than the parametric solid-state techniques at present in use.

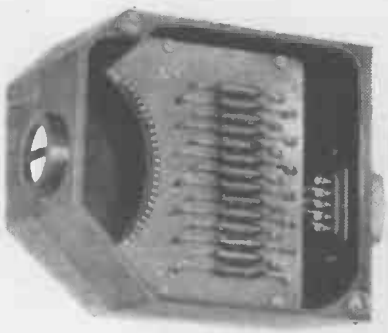
SENSING DEVICES

Space vehicle attitude sensors were shown by R.A.E., Farnborough. One very elegant sensor, for use in U.K.3, was described as an optical potentiometer. A slit image of the sun is formed on an array of phototransistors arranged in an arc of a circle whose centre is at the slit. Each of the phototransistors is connected on to a resistor chain forming a potential divider. On illumination, a transistor conducts and taps the potentiometer chain, with the result that the device gives an output voltage proportional to the angle of incidence of the light.

Tidal air integrator for continuously measuring and recording volumetric air flow in human breathing was demonstrated by Mercury Electronics. The patient breathes through a tube in which a wire gauze constriction is placed (pneumotachograph head) and the differential pressure across the constriction is proportional to the velocity of the breathed air. This differential pressure is measured by a micromanometer and the resulting velocity signal is then integrated in a separate unit to give a continuous measure of air volume. Normal breathing rhythm and any other effects such as coughing are clearly shown on recordings. The integrator comprises a transistor circuit controlling the charge applied to a capacitor. Total volume of air breathed during a given period can be registered by an electromechanical counter: this is operated by pulses obtained by discharging the capacitor through an electronic switch when a predetermined charge threshold is reached.



Tidal air integrator developed by Mercury Electronics, showing pneumotachograph head in front and integrator unit on right.



Above: "Optical potentiometer" developed at R.A.E. for use in space vehicles, including U.K.3.

Right: Solartron vibrating cylinder pressure transducer.

Vibrating cylinder pressure transducer, a new type of measuring element suitable for telemetering in widely spaced tank farms and other such plant, was demonstrated by Solartron. Intended mainly for measuring liquid level by head pressure in storage tanks, the device comprises a thin-walled cylinder of magnetic material with one end closed. Inside the cylinder are a drive coil and a pick-up coil, and these are electrically coupled through a small amplifier to form an oscillatory circuit which causes the cylinder to vibrate at its natural frequency. The cylinder is enclosed by a container into which liquid is fed by tube from the bottom of

the storage tank, so that liquid plus atmospheric pressure is applied to the outside of the cylinder and atmospheric pressure to the inside. The vibration frequency of the system then varies with the differential pressure on the cylinder walls, according to a known non-linear relationship. Electrical signals produced by the oscillating circuit are transmitted to remote frequency measuring equipment, operating on the counter-timer principle, and the resulting digital display gives the liquid pressure (or related variable such as liquid level or quantity) in appropriate units. The non-linearity of the transducer is compensated in the counter-timer by a pulse dropping technique. Good accuracy and long-term stability of calibration are claimed for the device.

Relative humidity transducers.—The ability of ion-exchange resins to take up water but not dissolve is utilized in a new type of relative humidity measuring element, shown by Wayne Kerr, which provides an electrical output signal. A thin film of resin is deposited on an insulating substrate incorporating two interdigital metal electrodes, and in this arrangement the surface conductivity is proportional to the ambient relative humidity. The resistance between the electrodes is measured by a self-balancing miniature a.c. bridge operating at 2 kc/s and this is displayed in terms of relative humidity on a pointer indicator with two scales, one calibrated 20-60% r.h. and the other 60-95% r.h. Temperature coefficient, constant over the whole measuring range of the transducer, is +0.4% r.h. per 1°C rise in temperature.

Semiconductor radiation detectors are becoming more widely used and in many cases are replacing conventional methods of detection. Gamma radiation, γ-particles and β-particles can be detected with surface barrier semiconductors or with junction types by varying the depletion layer thickness to suit the type of radiation. Semiconductor and conventional radiation detectors were seen on many stands, and a personal gamma dosemeter which gave an audible 2-kc/s tone output modulated to give pips of decreasing duration as dosage increases was featured by Isotope Developments Ltd. Here the detector is an ionisation chamber with an energy range of 50 keV to 2 MeV.

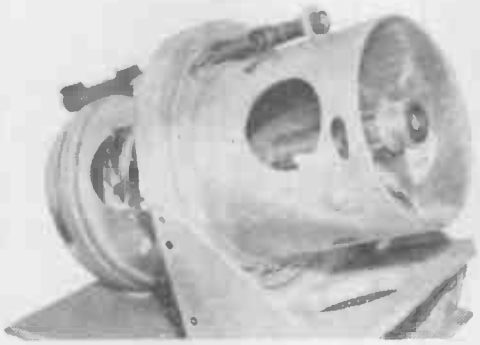
MEASUREMENT AND ANALYSIS

Laser devices held a prominent position in the exhibition and exhibits included two rangefinders. The small beam-widths obtainable, which enable specific objects to be used for ranging without echoes from the surroundings, and the compactness of the apparatus make laser rangefinding attractive, particularly for low-level altimeters. The Services Electronics Research Laboratory displayed an equipment with a range of 1,000 feet and an accuracy of about 5 feet, using a pulsed gallium arsenide transmitter, about the size of a small torch, with a peak power of 10 watts. The equally small receiver has a sensitivity of 0.1 μwatt and is situated at the focus of a parabolic mirror (see picture). Although some high-performance radars have been known to resolve overhead high tension cables, this elegantly simple and compact system has been shown capable of measuring heights of trees on experimental flights.

Specific gravity meter demonstrated by Sangamo Weston continuously measures the density of a liquid, on the hydrometer principle, by determining the electrical current necessary to maintain an immersed metal plummet at a given level in the liquid—the buoyancy of the plummet depending on the s.g. of the liquid. The ferrous plummet is suspended by an electromagnet within a vertical open-ended plastics cylinder immersed in the liquid, and its vertical position is measured by search coils fed with 500 kc/s a.c. The position measurement is fed back to the suspension system, giving a closed-loop servomechanism which maintains the plummet at a fixed height in the liquid. Depending on the liquid density, more or less electrical power is needed to maintain the plummet's position, and in fact the suspension magnet current varies inversely with the density of the liquid. This current is measured and used for indicating or recording the s.g., which can be done over a range of 0.4 minimum to 2.0 maximum.

Neutron flux measurement.—A miniature fission chamber was shown by Elliott-Automation for monitoring neutron flux in reactor cores. The device, which is 1in long and $\frac{1}{4}$in diameter, detects thermal neutrons with a coating of uranium 235, 238 or a mixture of both. The usual fission of the uranium nuclei takes place and produces radio-active fragments which are then detected in a stainless steel ionisation chamber containing helium and polarized with 75 volts. The device can withstand a temperature of 550° C and measure flux densities between 10^{11} and 10^{14} neutrons cm^{-2} sec^{-1}. The sensitivity is 2×10^{-17} amps per neutron per cm^2.

Liquid composition meter shown by the N.P.L. is based upon the comparison of dielectric constants. The instrument was required for on-line computer control of chemical processes and measures the composition of an ethanol-water



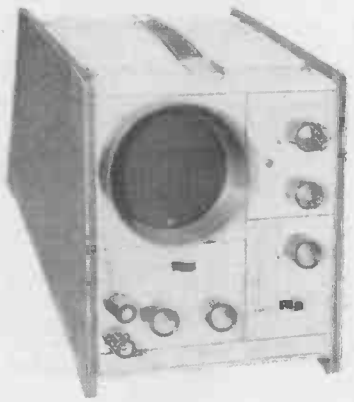
Laser rangefinder, with application in low-flying aircraft, using semiconductor laser. (Services Electronics Research Laboratory.)

Top of Sangamo Weston specific gravity meter, with a measuring cylinder shown on the right.

mixture. The mixture and a reference solution form the dielectrics of two capacitors which are used as the frequency controlling component in a bridge-type r.f. oscillator. The construction is such that the cell with the reference mixture is placed in a pipe carrying the mixture whose composition is required. A variable frequency oscillator sweeps the range 19-37 Mc/s and at either resonant frequency the oscillator grid current rises sharply giving pulses which are fed to a flip-flop whose output can be used with digital or analogue information processing equipment. Effects of temperature changes in the measured stream are reduced since both mixtures are subjected to the temperature variation, and temperature sensitivity is also reduced by frequency scanning in a linear manner.

The instrument will cover the whole range of dielectric constants of the water-ethanol mixture (26 to 81) and it is anticipated that other mixtures with dielectric constant falling low as 6 could be accommodated.

O-level oscilloscope. A low-priced simple oscilloscope, the Serviscope Minor, developed to meet Nuffield Committee requirements for an instrument for teaching O-level modern physics, was shown in the educational section by Telequipment. Weighing only 5 lb and measuring 6in × 6in × 9in, it has a 2¾-in c.r.t. and a Y amplifier bandwidth of 30 kc/s.



Telequipment oscilloscope designed for teaching "O"-level physics.

Sensitivity range is 100 mV to 50 V per 0.5 cm graticule division. Controls have been reduced to a minimum (brightness/on-off, focus, timebase speed, Y-shift, Y-amp. gain) and operation is further simplified by an automatically locking timebase. The timebase speed can be varied from 100 μs to 100 ms per 0.5 cm graticule division.

Automatic recording balance was displayed by U.K.A.E.A. Atomic Weapons Research Establishment. Electronic balances often use the variation of capacitance to determine the balanced condition, but this instrument was required to handle radioactive materials and total enclosure was necessary. This resulted in the use of variation of inductance of a coil, which was external to the glass-enclosed apparatus, by an iron dust core, which was internally connected to a balance pan. Movement of the balance beam changed the frequency of an oscillator tuned to a 10.7 Mc/s. The circuitry which follows the oscillator gives a d.c. output proportional to the frequency change and is used in a servo system to return the pan to balance by a restoring force applied to a solenoid, which is provided with temperature compensation and damping. The current to the solenoid is passed through a standard resistance and the p.d. is measured with a digital voltmeter. The method is useful for measuring weights up to 1.5 gm with a sensitivity of 0.2 mgm.

CIRCUITS AND INFORMATION PROCESSING

RC active filters.—Apart from new manufacturing methods microminiaturization has brought about the need for new circuit techniques, one requirement being the elimination of inductances, since these circuit elements are extremly difficult to fabricate on a microminiature scale. One method has been to use crystal filters and follow these with RC amplifiers, but this still leaves a lot to be desired for many applications. Frequency selective RC amplifiers built in thin-film and integrated solid state form were shown by AEI Telecommunications Division and include negative impedance converters and inverters. Response curves normally associated with circuits including inductors have been readily achieved. As an illustration conventional filters were shown and compared with RC filters, and in particular a low pass filter with one pole at a finite frequency and one at an infinite frequency with a ripple of 1dB and a stop band of 30dB was shown.

The current interest in design automation was maintained at the exhibition by the Post Office Engineering Department. A method of using computers to design wide-band transistor feedback amplifiers was presented and relied upon the computer to perform nodal analysis and computer stability margins, with the aid of Nyquist diagrams, of multiple feedback loop amplifiers, from measured admittance parameters. A directly coupled three-stage feedback transistor amplifier circuit was shown which had been designed with the aid of a computer, had constant gain up to 10 Mc/s, and the input and output impedances were precisely defined by the feedback. Computed and measured characteristics of an amplifier up to 1000 Mc/s were also displayed.

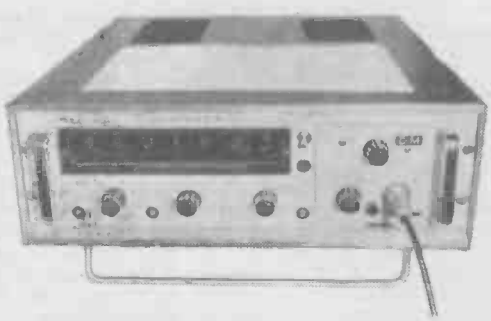
Tuning active filters.—One of the difficulties in providing variable tuning controls in active filters (using transistor, R, C combinations) is that several potentiometers, each associated with an active circuit element, have to be ganged. The Royal Radar Establishment showed a technique for providing automatic electronic ganging so that only one variable tuning control has to be adjusted. The circuits demonstrated used electronic integrators as basic units for synthesizing the required filter transfer functions, and normally each of these would be preceded by a potentiometer to permit tuning by variation of the integrator CR product. In the R.R.E. technique the potentiometers are replaced by electronic input-signal sampling switches, which alter the effective CR products according to the sampling period, and all these electronic switches are operated by a common pulse generator with variable mark/space ratio. Ganged tuning is then obtained by applying a variable control voltage to the pulse generator to adjust the mark/space ratio. Examples of circuits demonstrated included a self-tuning filter providing high-pass, band-pass, low-pass and notch characteristics at separate terminals; a tunable two-phase oscillator with a 10:1 range; and a tunable 5th-order low-pass filter with very steep cut-off.

Integrated matrix store of the magnetic, coincident-current type, shown as a demonstration model by Plessey-UK, uses new design and manufacturing techniques to achieve a large-capacity, small-size, random-access store with low cost per bit. Read-out is non-destructive. The magnetic storage elements are produced in thin-film form by electroplating on a substrate and the anisotropic square hysteresis loops are obtained by compressive mechanical stress, achieved by release of a tensile stress applied to the substrate during plating. Conductors are also thin films, laid on separate substrate. The size of a conventional magnetic matrix store is limited by noise resulting from half selection of the elements, so a new method of reading has been adopted in which

Demonstration model of Plessey coincident-current matrix store using thin film techniques.

frequencies of 8 and 9 Mc/s are applied to the X and Y selection conductors respectively. From the non-linearities at the "knees" of the hysteresis loops a 1-Mc/s difference frequency is obtained, and this has two possible phases depending on which knee of a loop, upper or lower, is magnetically biased (i.e. whether 1 or 0 is stored). To avoid destruction of the stored information by this a.c. read-out system, the storage elements are formed by two distinct magnetic films, magnetically coupled. One is of high coercive force and is used for writing in the conventional manner, by coincident-current d.c. pulses, while the other is of low Hc and allows a.c. read-out without wiping out the magnetic biasing of the coupled storage film. In the $16 \times 16 \times 10$ memory stack on show, cycle time was 30 μsec and read cycle time 10 μsec. A 10^6-bit store built on these principles would occupy about 3 cu ft and consume about 250 watts.

DVM with a.c. reference.—The accuracy limitations imposed by a resistive potential divider are avoided in a new digital voltmeter technique in which the usual potentiometer and d.c. reference voltage are replaced by an inductive voltage divider (auto-transformer) and a.c. voltage reference voltage. Such inductive dividers can have division accuracies as high as 1 part in 10^7. As embodied in a new instrument shown by Digital Measurements, the technique makes possible a very wide range of measurement, 10 μV to 1.1 kV, in four switched ranges, with good accuracy (0.001% f.s.d. of the a.c. reference voltage). A high-speed a.c.-d.c. comparator detects the unbalanced between the direct voltage to be measured (which is applied to an electrometer valve) and the a.c. output of the



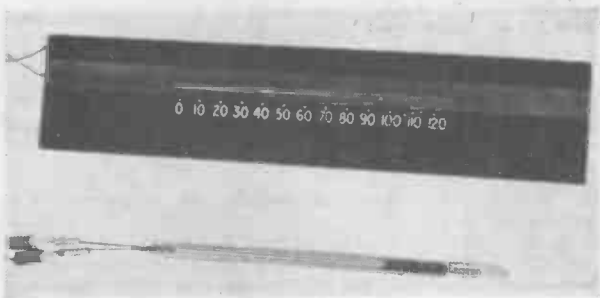
Digital voltmeter with inductive voltage divider, shown by Digital Measurements.

divider. A Weston standard cell is included to enable the first range, 10 μV to 1.1 V, to be set accurately. Resolution is 1 part in the maximum digital reading of 109999.

Acoustic telemetry.—Another item in the field of acoustics was a telemetry system used by the Research Department of the British Railways Board. This was designed to transmit acoustically the movements of parts of the overhead power supply system and pantograph, which are at a potential of 2 kV, to recorders at earth potential. This is achieved by using piezo-electric transducers at both ends of glass rods acting as insulators. At the high potential end of the system, measuring transducers are energized at an audio frequency between 3.9 and 7.2 kc/s and the modulated outputs are fed to the piezo-electric transmitters after amplification. This resultant amplitude modulated signal is accompanied by an unmodulated signal and the two are received at the low-potential end of the glass rod, amplified and fed to phase-sensitive detectors. The equipment works from d.c. to 50 c/s and records displacements, accelerations, etc., associated with the power supply system.

DISPLAY DEVICES

Linear milliameter.—A low pressure discharge tube may be used to indicate current by measuring the length of the glow discharge at the cathode. A linear relation between current and length of cathode glow occurs when an anode of equal length is mounted parallel to the cathode and at a sufficiently short distance to prevent the anode from glowing.



Mullard's glow discharge milliameter, which gives a linear indication of current up to 10mA.

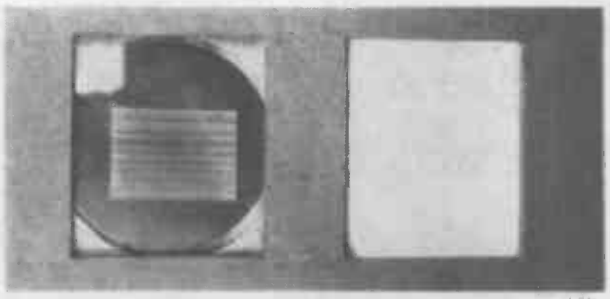
Mullard Research Laboratories demonstrated such a tube with a 5% accuracy of reading. The useful current range is dependent on the gas composition, pressure and electrode diameter. The device has a full-scale indication of 10 mA over a distance of 10 cm. The igniting potential (150 V) and maintaining potential (115 V) are fairly close, so the tube can be controlled by simple transistor circuits. A demonstration showed the use of the tube as a motor speed indicator, with calibration from 0 to 5,000 r.p.m.

Light guides.—Bundles of optical fibres through which light may be ducted were shown by Barr and Stroud. Light is transmitted along the fibres by total internal reflection at the interface of the fibre core and its sheath, which has a lower refractive index than the core. Flexible light pipes are made from 50μ fibres, and rigid rods from 10μ fibres which permit image transference owing to their rigidity. If one end of a rigid fibre rod is made larger than the other, a magnified

image is produced at the larger end, and *vice versa*. Contrast of the image can be improved by adding an outer absorbent sheath to the fibres and this effectively reduces "cross talk" between the fibres.

Faceplates: Fibres can be fused into a solid block, allowing application to coupling of image intensifiers and cathode-ray tube faceplates. Indeed, a c.r.t. faceplate was shown by R.R.E. for operation in bright surroundings (see picture). A high level of illumination at a c.r.t. screen causes reflections from the phosphor, decreasing the visibility of the image. The use of a fibre-optic plate increases the contrast by allowing light which is approximately normal to the screen to pass through the plate. Light incident at angles greater than the critical angle is absorbed.

Cascade image intensifier with a light flux gain of 10^5 was shown by 20th Century Electronics. It has two intermediate dynodes for electron multiplication, each comprising a phosphor and a photocathode deposited on opposite sides of a 4 μm thick mica sheet. Overall resolution is 30 line-pairs per millimetre and the final image appears on a screen of 39-mm diameter. Developed on the basis of original work by Professor McGee of Imperial College, London, the intensifier is designed for use in astronomy and particle physics.



Right-hand photograph shows a normal c.r.t. with trace under high ambient illumination. Left-hand picture shows the same trace under the same illumination, but with a fibre-optic faceplate. (R.R.E., Malvern.)

Commercial Literature

"**The Sig Gen Book 1**" is the title of a 26-page publication issued by Marconi Instruments Ltd., of St. Albans, Herts., on how to use signal generators for receiver measurements. It is split into seven sections covering source impedance, coupling to loop aerials, sensitivity, automatic gain control, receiver bandwidth (frequency response characteristic), selectivity, and spurious responses.
5WW 326 for further details

"**Impedance Measurements with a Q Meter**" is the title of another reference type of publication recently announced by Marconi Instruments. It gives theoretical and practical information and also possible pitfalls to look out for when conducting these tests.
5WW 327 for further details

"**Ten new products from Imhofs**" are contained in an eight-page catalogue H/143 now available from Alfred Imhof Ltd., of Ashley Works, Cowley Mill Road, Uxbridge, Middx. There are additions to their already extensive range of instrument housings and accessories, and make possible a new "square" form of styling, that is now optionally available on the majority of the racks in their International Series of Imracks. Other new items described in the catalogue include ventilation fan units, handles and chassis runners.
5WW 328 for further details

Modular Construction System.—Details of the ISEP (International Standard Equipment Practice) system of modular construction for electronic equipment housings are contained in a new twelve-page brochure (MG/104) available from the electronic services division of Standard Telephones and Cables Ltd., of Edinburgh Way, Harlow, Essex. The brochure is well illustrated and shows how, with standardized parts, the user can build different sizes of racking, sub-assemblies, circuit boards, multi-pole connectors and cubicles. This publications should be of particular interest to those building electronic equipment for the home and overseas Ministry and P.T.T. authorities as many of these have standardized on the ISEP system.
5WW 329 for further details

SGS-Fairchild semiconductor products are now classified under the following headings: Military, Professional, Industrial and Consumer. Catalogues covering these fields are available from the company's offices at 23 Stonefield Way, Ruislip, Middx.
5WW 330 for further details

Mullard Industrial Components.—The 1965 edition of "A quick reference guide to Mullard components" is now available from the company. Over a third of this 36-page publication is devoted to capacitors. Other items in the guide include a selection of resistors, electro-mechanical components, magnets, ferrite materials and assemblies, computer core assemblies, thin-film circuits, and piezoelectric materials. Requests for copies should be made to central enquiry handling, Mullard Ltd., Mullard House, Torrington Place, London, W.C.1.
5WW 331 for further details

The 1965 "**Electronic Valve and Component Data**" abridged catalogue of the English Electric Valve Company contains brief specifications of the products they manufacture at Chelmsford and Lincoln. These include ignitrons, rectifiers and thyratrons, magnetrons, transmit-receive and transmission blocking cells, solid state microwave devices, photo-multipliers, and glass-to-metal seals. Two of the 20 pages are devoted to an equivalents index that lists valves of various manufacturers for which EEV types may be used as replacements.
5WW 332 for further details

An "**Extended Scale Voltmeter**" employing a Zenar diode to achieve zero suppression is described in specification sheet 32 now available from the manufacturers, British Physical Laboratories, Radlett, Herts.
5WW 333 for further details

The 2500 series of "**Radiation-tolerant Television Cameras**" manufactured by Cohu Electronics Inc. are described in leaflet 6-327, which is available from the company's Kintel Division, whose address is Box 623, San Diego, California. One-inch vidicons are fitted to these 525-line cameras.
5WW 334 for further details

The second edition of the 19-page booklet describing the LFK4 "**Audio Transistor Package for Transformerless Amplifiers**" has been issued by the Entertainment Markets Division of Mullard Ltd., whose address is Mullard House, Torrington Place, London, W.C.1. This transistor package is intended for use in portable radio and audio equipment with output powers up to 750 mW at 9 V and 1 W at 12 V. The design method described in the publication is based on a report prepared by R. F. Brown of the Mullard Central Application Laboratory.
5WW 335 for further details

PARIS COMPONENTS SHOW

PARIS, PORTE DE VERSAILLES, 8-13 APRIL

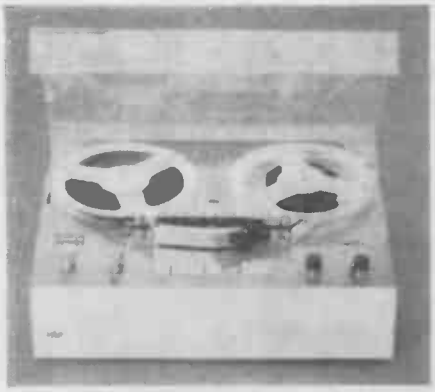
NOW that the exhibition has left the collection of halls on the east side of the Avenue Ernest-Renan and crossed to the main exhibition (*Le Hall Monumental*) under one roof, the *confrontation*, as the French say, which meets the eye on entering is more daunting than ever. The horizon is lost in the haze at the far corners of the hall; there are nearly 900 stands and one has to walk 5 km to see them all.

Obviously, any report must be highly selective and many items, especially those shown by British Manufacturers who will also be at Olympia next month, have been left for our coverage of the R.E.C.M.F. exhibition.

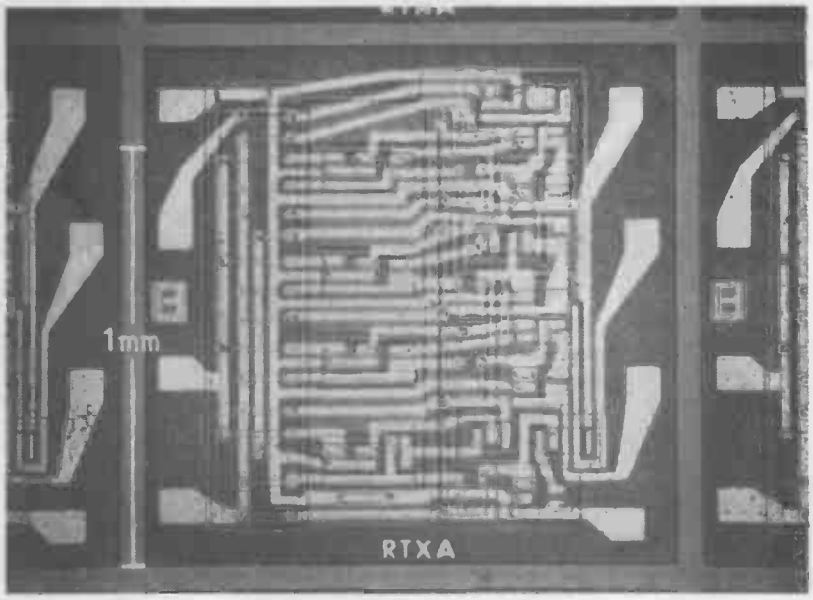
A branch of the main hall was this year set aside for what the organizers term the 1*er Salon International de l'Electroacoustique* but which did not differ much from the aggregation of the same firms in last year's general exhibition. Monsieur Gogny, who revives for one U.K. visitor memories of Voigt and his lone work for high quality in the mid '30s, was showing refined versions of his now well-known Orthophase ribbon-driven flat diaphragm speaker cells. Also a number of combinations of conventional moving coil units, conventional that is with the exception of the "woofer" units which incorporate a separate velocity-sensing unit, with separate magnet system, providing feedback to linearize the velocity characteristic of the main coil.

Another interesting audio exhibit was the new Braun TG 60 tape recorder designed to give "studio" performance comparable with the rest of Braun domestic quality equipment. The outstanding feature is the plug-in head assembly which permits rapid change-over between 2 and 4-track working.

In the main exhibition the real components, *pièce détachée*, are fittingly congregated around the entrance and as one penetrates into the hall the complication increases, with sophisticated measuring equipment at the four sides. For precision and quality in small metal parts it was pleasant to find an old-established Birmingham firm (Brandauer & Co. Ltd.) setting the standard. Many of these minute parts—contacts, transistor headers, etc. —are gold plated and P.M.D. Chemicals Ltd. were expounding their "Duplex" technique in which a heat

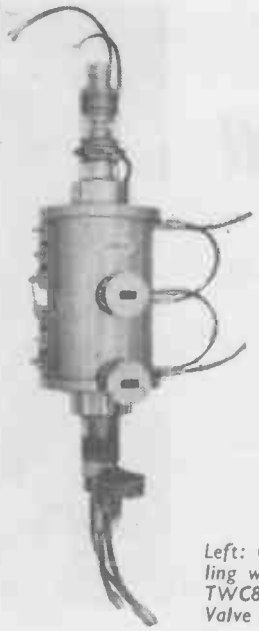


Braun TG60 tape recorder with plug-in heads



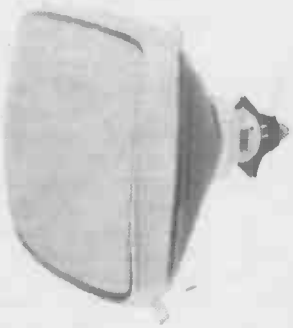
Photomicrograph of the SGS-Fairchild decade counter chip.

Telefunken 500 kw triode (RS1828).



Left: C-band travelling wave tube, type TWC827, by M-O Valve Company

English Electric KY366 vapour-cooled klystron.



Right: Colour display tube (A63.11X) by "La Radiotechnique" has pre-stressed (auto-protected) 63 cm rectangular screen

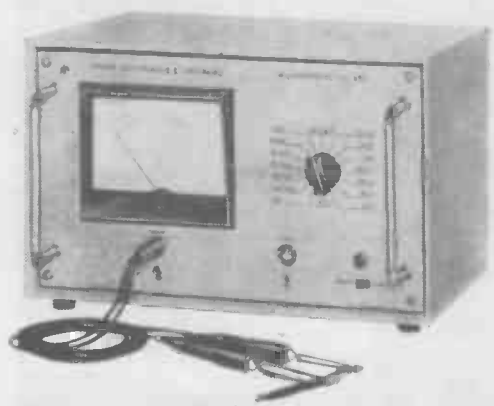
resisting gold layer is combined with a second coating to reduce porosity.

A striking demonstration of the low-noise properties of Filotex coaxial cables was given by inducing large-amplitude traverse mechanical waves in a vibration test bench. Also on this stand was seen a parallel-stranded flexible coaxial shielding (Type FMG) which is easier to strip than the conventional braiding. Sub-miniature coaxial cables shown by Precicable-Bour S.A. are made down to 1 mm external diameter (50 $\Omega \pm 4$, 93 pF/m, 0.87 dB/m at 200 Mc/s). A useful kit of inter-series cable adaptors and fixing spanners for most NATO stock numbers was shown by Greenpar Engineering Ltd.

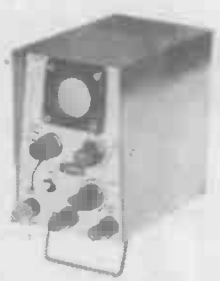
New n-p-n high voltage transistors (700 V, collector-to-emitter) and germanium p-n-p diffused alloy power types (325 V) switching 2A in $<2\mu$sec were announced by Bendix for use in television receivers. The all-planar techniques evolved by S. G. S. Fairchild were well exemplified by a single chip decade counter circuit (CμL958), measuring 1.25 mm square and containing four binary-triggered flip-flops with feedback. There are 24 transistors and 30 resistors and it consumes 160 mW at 4 V. Thin film techniques for R and C in conjunction with silicon integrated active circuits were represented by the Ferranti "Multilin" system.

Some things transistors cannot yet do—for instance, produce 8 kW at 6.3Gc/s; but this is the performance of the M-O Valve Company's travelling wave tube which was on show and which is in use at Goonhilly Down. Nor can they yet do the work of vapour-cooled klystrons such as the KY366 shown by English Electric and used in the Post-Office microwave links between Goonhilly and Plymouth for the "Earlybird" tests. The contrast is even greater at broadcast frequencies for which Eimac have produced a 250 kW vapour-cooled pentode (5CV250, 000A) and Telefunken a triode (RS1828) rated at 500 kW.

In switching circuits transistors have not yet entirely superseded mechanical relays, particularly glass-encapsulated reeds, typified "dry" by a new G.E.C. model



Milliohmmeter, Type R01, by S.E.N.



Acos model IDI200 1-in oscilloscope

Tektronix Type 422 portable oscilloscope

and "mercury-wetted" by the I.T.T. range. These are cheaper and have life expectances up to 10^9 operations. High-speed polarized relays of the Carpenter type are also less expensive than the transistorized equivalent shown by T.M.C., but in unattended situations or where skilled adjustment is expensive, the higher capital cost of the transistor version may be justified.

Two new colour television display tubes, both with rectangular screens, were shown, one by the firm "La Radiotechnique" which markets the Miniwatt and Dario valve and transistor marques in France, and the other by Sylvania. This latter tube has a new phosphor coating for the red dots containing the rare earth europium which enables the brightness to be brought up to the more sensitive green and blue levels. An overall brightness increase of 43% is claimed.

Among measuring instruments a milliohmmeter (Type ROI) by Société Electronique et Nucleaire was noted. It has a range of 10 $\mu\Omega$ to 10 kΩ and uses long thin leads and crocodile clips for connection to the circuit to be measured. Actually the jaws of each clip are insulated from each other one being used to establish a known current through the circuit under test and the other to measure the voltage developed across it. As the input resistance of the voltmeter is about a megohm the lead resistances can be neglected.

Oscilloscopes showed no striking advances in performance, but there was a trend among the high-grade makers to produce models of smaller size and weight, typical examples being the Hewlett Packard Model 132A double-beam tube, using Nuvistors for low microphony in the channel amplifiers, and the Tektronix 422 measuring only $16 \times 8\frac{1}{2} \times 6\frac{3}{4}$ in, also with double-trace operation and a wide selection of functions for all kinds of scientific work in the field. The ultimate in portability was seen on the Cosmocord stand where a new range of inexpensive vibration measurement equipment included a 1-in oscilloscope measuring approximately $5\frac{1}{4} \times 4\frac{1}{2} \times 3$ in.

COLLOQUIUM ON MEMORY TECHNIQUES

PARIS, UNESCO, 5-10 APRIL

AN attendance not far short of 600 served to indicate the breadth of interest in this subject. While the commercial rewards in a future dominated by computers are likely to be high for anyone making a major breakthrough in capacity and/or access time, this alone would not account for the fascination of the problem for applied physicists, technologists and engineers who have the planning of computer systems. Work on thin magnetic films, opto-electronics, cryogenic devices and ferroelectrics have produced a wealth of paper work and more questions than answers, but the time will no doubt come when the dominance of the ferrite ring core matrix in present-day computers will be superseded.

Successive miniaturization giving better packing densities, and multi-aperture cores permitting non-destructive read-out have kept ceramic ferrite cores ahead of the pack so far. Although a higher Curie point is possible with lithium, and other minor improvements can be obtained with various additives, H. P. Peloschek (Philips) thought that the original manganese-magnesium square loop ferrite was likely to remain the most-favoured type for a long time on account of its uniformity, reliability and fast switching time. He saw no sensational improvement in these directions, but thought that higher saturation magnetization and crystal anisotropy were possible, and that better ceramic structure might be found to improve the squareness of the hystersis loop, degraded by the increased effect of disturbances (pores, etc.) in miniature structures. Most speakers supported this view and agreed that competitors using other methods were aiming at a moving target.

Much work has been done on thin magnetic films which promise faster and cleaner switching because the change of magnetic state depends on 180° coherent rotation of the molecular magnetization in what is virtually a single domain and is independent of the wall motion between domains which is dominant in bulk materials. J. I. Raffel described work at M.I.T. on a high-capacity film store giving 3,200 word lines on 350 digit lines (1.1×10^6 bits) on a glass substrate only 10 inches long. The magnetic material is deposited by evaporation in a vacuum and special precautions against blemishes (e.g. dust) in preparation are necessary, as one open or shorted line could spoil the whole store. Non-destructive read-out is possible with sandwich films in which a "hard" (Ni Fe. Co) film is separated from a soft (Ni Fe) film by a thin non-magnetic layer. The coupling between the magnetic films in these conditions is parallel and identical in direction and this unexpected phenomenon is as yet not satisfactorily explained, though work by Prof. Néel and his colleagues at C.N.R.S. at Grenoble suggests that three mechanisms may be involved: (1) contacts through microholes in the non-magnetic layer, (2) diffusion into this layer of ferromagnetic elements and (3) long-range interaction through the polarization of conduction electrons. The dominant cause is dependent on the metal used for the intermediate layer.

An unusual photoelectronic memory depending on persistent internal polarization (p.i.p.) in a layer of powdered photoconductive material in air, and also exposed to an electric field was described by H. P. Kallmann (Univ. of New York). The information is written-in by a light beam and can be released by light in the absence of the electric field, but with both field and light off it is calculated that the latent image would last, under dry conditions, for 10 to 12 years.

Another unusual memory principle was described by J. T. Chang *et al* (Bell Tel. Labs.) and depends on the rotation of polarization of transmitted light through a mosaic of gadolinium iron garnet crystals on the application of a magnetic field. The magnetization of the iron sub-lattice of the garnet produces a rotation in opposite senses for magnetization along or against the direction of light, so the elements can be interrogated non-destructively.

In the concluding session J. A. Rajchman (R.C.A.), a pioneer of memory techniques, summarized the conclusions of the conference and gave his views of future prospects. Too much emphasis he thought should not be given to

miniaturization and perfection of integrated memories themselves without at the same time considering the integration of the access switching circuits which at present cost about as much as the matrix itself. Junction transistors at present capable of being packed at 20 or more to the "chip" were too big, and one had to think in terms of thousands in the same area. Meanwhile diodes which could be laid down at 60 to the inch must offer the best prospect for integration during the next 2 or 3 years. Tunnel diode characteristics were sensitive to manufacturing tolerances and he thought that the future might lie with field effect complementary pairs which were capable of nanosecond switching times with negligible energy requirements. But we would still need 6 to 8 transistors per bit.

In spite of slow progress and pessimism in some quarters he thought that superconducting memories had as much chance as any of beating the ferrite core. They contained only conductors and were simple to manufacture, energy requirements were small and switching thresholds sharp.

The attraction of optics as providing the ultimate in speed of operation was in Dr. Rajchman's view illusory. Compared with fibres, necessary for the conduction of light to the appropriate part of the memory, the copper wire for the conduction of electricity was a great invention; it was just as fast and much more efficient. Lasers with their capability of concentrating large energies in a small spot were not yet sufficiently developed to judge whether a practical application could be made.

LETTERS TO THE EDITOR

The Editor does not necessarily endorse opinions expressed by his correspondents

Class D Audio Amplifiers

THE article in the April issue by Messrs. G. F. Turnbull and J. M. Townsend concerning their "pulse width modulated," or "class D," audio amplifier circuit interests me very much. They have produced a design essentially similar to the one I described in this same journal over two years ago (Letter to the Editor, March 1963), although I am assured that they were unaware of my circuit until after their article was complete. We both advocate arrangements in which overall negative feedback is used to generate the basic switching, and apparently we were led independently to this principle from consideration of different kinds of automatic control system.

Since the publication of my letter I have several times heard the comment that this type of switching must lead to distortion, since it introduces a variation of the basic switching frequency when a modulation waveform is applied and that this variation must give rise to complex sidebands which will spread down into the a.f. band more seriously than would have been the case with the more usual fixed frequency of switching. But is this variation of the frequency necessarily a bad feature? Might not the feedback be cleverer than we are, and "know" that a judicious amount of frequency modulation can actually reduce the troublesome low-frequency sidebands? In fact I am sure that this is the case, and that the feedback effectively modifies both the mark-to-space ratio and the frequency of the switching square-wave in such a manner as to give a very worthwhile reduction of the spurious sidebands at the low frequencies.

Consider the basic arrangement as shown in Fig. 1, which is almost a reproduction of Fig. 8(a) from the article in the April issue. The amplifier A and the capacitor C form an integrator using the well-known "Miller" principle, and the resistors

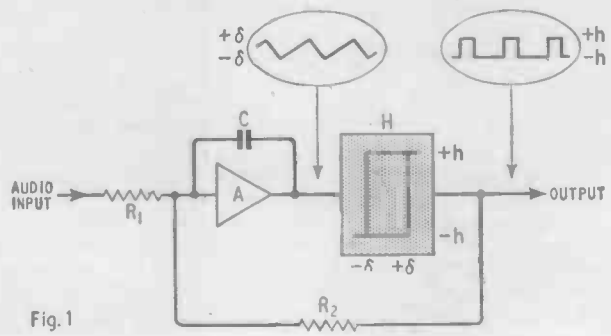


Fig. 1

R_1 and R_2 form a feedback network also in a familiar way. If the amplifier A has a high gain, so that voltage swings at its input are negligible, and ahigh input impedance, so that no current is wasted, then the feedback network delivers a current proportional to the voltage error at the output point and this current is integrated by the capacitor C. Thus the output voltage of the amplifier A is at every moment a measure of the integral of the error of the overall amplifiers and the hysteresis circuit H trips over whenever this accumulated (error × time) integral threatens to get outside the range represented by the voltages $\pm \delta$.

We can thus draw a diagram of the *error* waveform of the overall amplifier by subtracting the ideal linear output voltage.

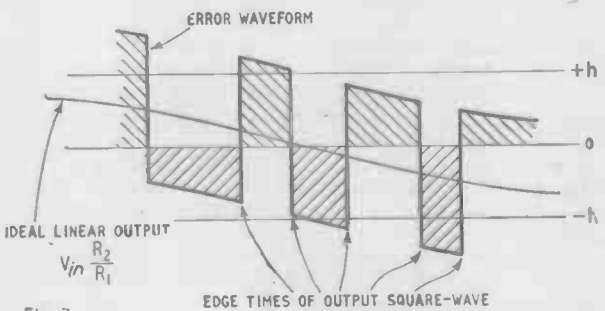


Fig. 2

which is $V_{in}\frac{R_2}{R_1}$ from the actual output square wave that the system gives. The result will look like the waveform in Fig. 2. where the vertical edges have the same height and timing as the edges of the square-wave output, but are joined together by portions of the ideal linear output as a result of the subtraction. Now clearly we require this *error* to be as free as possible from components of frequency in the a.f. band. The modulation system we are discussing, and only this system, has the property that each single pulse in this error waveform has the same voltage × time integral, indicated by the areas shaded on the diagram, as all the other pulses.

Now this means that not only are the very low frequency components of this error waveform always exceedingly small, but that their increase of size along the frequency spectrum is parabolic rather than linear. In contrast to this, conventional fixed frequency p.w.m. generates sideband components of constant amplitude even when their frequency is close to zero,

such as when the signals at the input are roughly one-quarter or one-sixth of the switching rate. Now the writer is forced to admit that he has been unable to find a satisfactory method for obtaining a proper Fourier analysis of this switching waveform, perhaps some reader may be able to help, but approximate methods suggest that the advantage gained with this arrangement extends over a band of frequencies up to at least a third or a half of the basic switching frequency, that is to say throughout the range that is of practical importance. It will be realized, of course, that if very heavy modulation of the mark-to-space ratio is used then the switching rate falls drastically and severe distortion occurs, but it will be found that the effects are not really so very much different when a system of the constant frequency type is overloaded, and the only honest course is to quote a figure for maximum output power based on a maximum modulation depth of perhaps 75%.

Thus this basic system of modulation, involving both the mark-to-space and the frequency of the switching wave, obtained with the negative feedback kind of circuit appears to be theoretically superior to the more usual fixed frequency p.w.m. scheme. This means that such a circuit has the practical advantage that a lower switching rate can be used to obtain a given level of performance, and this in turn eases the speed requirements on the final power transistors. The selection of these is at present the most difficult part of any Class D amplifier design, so that easing of the requirements is of considerable value.

But this is not the only advantage of the negative feedback system. Consider Fig. 1 again and think what is actually involved in block H. This is not merely a switch with hysteresis, but a power amplifier capable of driving some watts into a loudspeaker. It will normally comprise four or more transistors of which several are being pushed for economic reasons to their limits of power and switching speed. Thus it is naive to assume that the pulse edges will emerge at the loudspeaker circuit with accurately defined amplitudes and uniform time-delays. But in a circuit without feedback this assumption has effectively been made and if it is wrong even by only a few per cent. then a corresponding distortion will be found in the output. The negative feedback, however, corrects for errors of these types and it is a feature of this kind of amplifier that feedback can be put over so many stages that the correction is easily made almost perfect. The only worry is that the circuit may possibly "squegg" if you are exceedingly careless; it will, of course, "hoot," as it was intended that it should!

This makes it clear that the only way in which the circuit can misbehave is by a weakness of the feedback arrangement. Thus the amplifier A in Fig. 1 must take only a negligible input current and its input voltage must not vary appreciably. If these conditions are not met then not merely does distortion appear, but power line hum is able to creep in and bass response can be lost. My circuit of March, 1963, can be substantially improved in this respect by the use of either a transistor of exceptionally high current gain or a Darlington pair in the first stage. The circuit of Turnbull and Townsend in the April issue has a lower impedance feedback network than mine, so that it will be likely to suffer less, but even so the selection of a high gain transistor for Tr1 will probably be worthwhile. The exact mechanism of this interference can be rather subtle, but the essential effect is that any variation of the collector current of this transistor due to any cause such as variation of the voltage applied to the load injects a current, reduced only by the current gain factor, directly into the feedback bridge. This in turn causes a corresponding change of the voltage at the loudspeaker and hence an unwanted contribution to the output.

It seems rather unkind to criticize the details of the circuit given in the April issue when I am so much in agreement with its basic principles. Accordingly I will content myself with asking that interested readers should compare the two circuits before building either of them, and I would also like to point out that far and away the most difficult problem for many readers will be in obtaining transistors fast and powerful enough to work adequately in the final stage. The day when transistors become like vacuum tubes and are always able to function far beyond the highest audio frequencies whatever their current or power capabilities has not yet arrived. When it does we may well see the Class D circuit as the only type of a.f. circuit used in any numbers.

Cheadle. K. C. JOHNSON

Pulse Width Modulated Audio Amplifier

IT has been my pleasure to read the valuable article by G. F. Turnbull and J. M. Townsend on pulse modulated audio amplifiers in the April issue.

I would like, if I may, to underline the muffled plea (conclusions, p.167) for the development of transistors or G.T.O.s appropriate to power outputs of 20 to 100 watts r.m.s.

In the current range, there is a pronounced notch between audio types having inadequate switching speeds, and h.f. power devices which are too good, and correspondingly expensive for this application. It is to be hoped that the more enterprising semiconductor manufacturers will force the potential of class D systems in the industrial as well as domestic markets.

There is a good choice available for the lower-powered stages with prices ranging from under one shilling to about 4s for planar epitaxial devices. I mention this to make the point that other components, e.g., a decoupling capacitor, can cost the manufacturer more than a transistor.

The editorial of the April issue makes appropriate comment about "habits of thought induced by long experience with valves. . . ." Historically stress has always been laid upon the number of valves employed in a particular piece of equipment. There is surely no longer any reason to regard transistors differently from other circuit components, such as resistors and capacitors.

This argument is relevant when comparing open and closed loop class D systems. It is perhaps worth mentioning that in an open loop system employing double edge modulation the h.f. energy is confined to blocks centred on the *fixed* p.r.f. and its harmonics, and that filtering therefore tends to be easier. Whilst filtering is frequently unnecessary in domestic installations due to the large h.f. resistance of most loudspeakers, it is important in high-power p.a. applications in order to avoid radiation.

On this topic and again referring to "habits of thought," we ought not to be prejudiced against an audio amplifier containing a "local oscillator" any more than we are towards super-het receivers. In both instances, however, adequate design is called for.

Oxted, Surrey. D. R. BIRT

Klystron Action

I CANNOT agree with Mr. K. E. Hancock's qualitative description of the action of the klystron in the October, 1964, issue. Contrary to his statement in the script on page 509, the charge distribution in the resonator of Fig. 4 gives a field distribution most favourably disposed towards accelerating the beam electrons within it.

Furthermore, although a finite transit time in the gap (G_1 to G_2) does affect the intensity of velocity modulation of the beam (by a gap factor $\sin\frac{\phi}{2}\Big/\frac{\phi}{2}$ where ϕ is the transit angle), the phenomenon of bunching can be explained without reference to it. The main factor governing the velocity of an electron leaving G_2 will be the potential to which it has been raised at this point, and it can be easily shown that the velocity of an emergent electron is given by $\mu_0\left(1+\frac{v_1}{V_0}\right)^{\frac{1}{2}}$ where v_1 is the instantaneous potential difference between G_2 and G_1, V_0 is the steady p.d. between resonator and cathode and μ_0 is the electron velocity with no cavity resonance. Bunching is thus obtained by electrons entering the retarding field space near the repeller at different velocities as v_1 goes through its sinusoidal cycle. The modifying gap factor will have little effect upon this as the transit angle is normally of the order of 1 radian.

If the bunch can be timed to return to the resonator when

it is again in the phase shown in Fig. 4, it will be retarded in velocity, thus giving up energy to the field.

Cardiff. E. H. JONES
Welsh College of Advanced Technology.

Resistances and Reactances in Parallel

IN reply to Mr. de Visme's letter in the January issue, let me say that the graphical method for determining the equivalent series circuit of a given R and X in parallel, and *vice versa*, has been described in the literature. At a second-hand book shop I bought a nicely bound volume of *Experimental Wireless and The Wireless Engineer* for 1927, from which one obtains an excellent insight into "the state of the art" at that time.

Mr. de Visme's method is used in two articles: "Some New Coil Impedance Diagrams" by W. A. Barclay on page 87, and "Alterations to the Modulating Panel at 2LO," by Green, Hewitt and Petersen on page 467. In each case the authors give credit to F. M. Colerbook for originating the method in an article "The Graphical Analysis of Composite Impedance," in *E.W. & W.E.* for December 1924.

The late F. M. Colebrook is, of course, well known for his book "Basic Mathematics for Radio and Electronics," which, in the 1927 volume of *E.W. & W.E.* was running in serial form. Another contributor, describing the horizontal Hertzian aerial, and a graphical method of amplifier coupling design was that Peter Pan of radio technical literature, M. G. Scroggie.

Brisbane, Qld., Australia. A. R. WHITE

Audio Topics—Nomenclature

IN view of the increasing interest in class D amplifiers it is surely pertinent to begin this new design phase with accurate terminology.

It was in the *Wireless World* of April 1946 that "Cathode-Ray," dealt with the term "pulse width" and showed that this was slovenly jargon for the appropriately designated concept of "pulse duration." However, pulse duration modulation has been customarily used for a different sort than that associated with your class D. Surely the correct and most widely used term for this type of amplifier is "pulse-ratio" modulation?

London, S.W.19. P. F. COOK

I THINK I voice the feeling of the p.a. profession when I say we wish to remain old fashioned enough even with our latest transistor amplifiers, to retain sine wave ratings.

May I make a point about "pop" music? The dynamic range here is much less than the 10dB mentioned—in many cases less than 3dB! As this class of programme takes up so much broadcast time, and accounts for a large volume of disc sales, surely this type of signal must be considered?

Luton, Beds. HAYDON G. WARREN

National Certificate Courses

YOUR correspondent Mr. I. Leslie (April issue) complains that after working for 7 years and having three A Level passes he cannot enter directly a Higher National Certificate Course. When he left school two avenues for his further advancement would in theory be open to him:—

(1) to follow technological courses leading to O.N.C. and H.N.C.

(2) to acquire sufficient G.C.E. passes at O and A level to qualify for entry to a degree course, if he had not sufficient already, and to proceed either as a part-time student for a London External degree or as a full-time grant-aided student (at a university or technical college) for an internal or a London External degree.

He has elected to follow the second avenue and now appears to be ready to enter on the degree course proper. If it happens that he has not yet obtained qualifications acceptable for admission as a corporate member of a particular professional institution, apparently without having years ago considered what he would need for this purpose, he is in no position to complain that the regulations of avenue (1) above are not suited to his particular case.

In any case there are a number of professional institutions to which persons active in the field of electronics might usefully apply.

University of Newcastle Upon Tyne. P. SHORT

Average Power

IN your editorial comment on the question of power ratings of audio amplifiers you use the expressions "watts r.m.s." and "sine-wave r.m.s. power." It is clear from the context that what is actually meant is average watts and average power, and thus the addition of the letters r.m.s. is both unnecessary and misleading.

Virginia Water. L. GOODALL

REPRINTS OF "W.W." ARTICLES

IN response to requests we give below a list of the articles which have appeared in *Wireless World* and are, or will be, available as reprints.

Wireless World Oscilloscope	
Parts 1, 4, 5 & 6 (Mar., June, July & Aug. '63)	5s 0d
Part 2 (April '63)	2s 6d
Part 3 (May '63)	2s 6d
Parts 7 & 10 (Feb. & Oct. '64)	2s 6d
Parts 8 & 9 (Mar. & April '64)	2s 6d
W.W. Audio Signal Generator (Nov. & Dec. '63)	3s 0d
Transistor Audio Power Amplifier & Pre-Amplifier; Tobey & Dinsdale (Nov. & Dec. '61)	3s 6d
Wireless World Crystal-Controlled Transistor F. M. Tuner (July '64) available soon	
Transistor High-Quality (Stereo/Mono) Audio Amplifier; Dinsdale (Jan. & Feb. '65) available soon	
Low-cost High-Quality Amplifier; Baxandall (Feb. '58)	3s 6d
F.M. Tuner (Valve); Amos & Johnstone (April, May & July '55)	2s 0d

"Where do transistors go . . ."—*Some of those that fall by the wayside find their way to PMD Chemicals Ltd., of Coventry, who find that it pays to recover the headers and also the gold which is plated at considerably greater thickness than on jewellery. Rejects arrive by the 1 cwt sack and stocks awaiting processing can be anything up to 10 tons!*

Satellite Communications Service Begins

GOONHILLY STATION MODIFIED FOR EARLY BIRD SYNCHRONOUS SATELLITE

LAUNCHING of the Early Bird synchronous satellite on 7th April effectively established the first satellite radio communications system to be used in a commercial telephone service. Previous satellite communications systems have been purely experimental. After an initial test period, now nearing completion, the new system will carry a proportion of the transatlantic telephone traffic normally conveyed by cable between Europe and North America. Nevertheless it is still only a trial commercial system. The economics and technical advantages of synchronous satellite working have still to be assessed, relative to h.f. radio, undersea cables and the rival non-synchronous satellite systems, before a decision can be made on the best type of satellite scheme for global communications.

The Early Bird system will provide up to 240 telephone circuits between an American earth station, at Andover, Maine, and any one of three European earth stations, at Goonhilly Downs in Great Britain, Pleumeur Bodou in France and Raisting in W. Germany. Continuous operation is possible, but initially the service will be restricted to peak telephone traffic hours between noon and midnight, Monday to Friday. The system may also be used for occasional experimental television transmissions. The three European stations will operate consecutively, each carrying the whole of the satellite-system traffic for one week in every three week period. The remaining two weeks of the period are for standby operation and maintenance respectively. Switching centres at London, Paris and Frankfurt will establish the required telecommunication circuits throughout Europe, to and from whatever station is acting as the satellite terminal.

Early Bird, otherwise known as HS-303, has been placed at a height of about 22,240 miles and moves in a synchronous equatorial orbit which causes it to be stationary with respect to the earth at a point 27° 30'W above mid-Atlantic. Built by Hughes Aircraft Company, U.S.A., the HS-303 is constructed as a cylinder 3ft in diameter and 4ft 6in high with projecting aerials. The cylinder carries on its surface about 6,000 solar cells, providing a 45-watt power generator, and encloses two communications transponders, a v.h.f. telemetry transmitter, two microwave beacons and a battery of rechargeable cells. The two transponders (one for each direction of signal transmission) receive signals from a colinear aerial array and use a common travelling-wave tube transmitter, which has an output power of 4.3 watts and feeds a co-axial slot aerial. For telemetry, four v.h.f. whip aerials are used.

Communications signals are transmitted from the European earth station on 6.30 Gc/s and received by one of the satellite transponders, which re-transmits them on 4.10 Gc/s to the U.S.A. In the reverse direction, signals are transmitted from Andover on 6.39 Gc/s and received

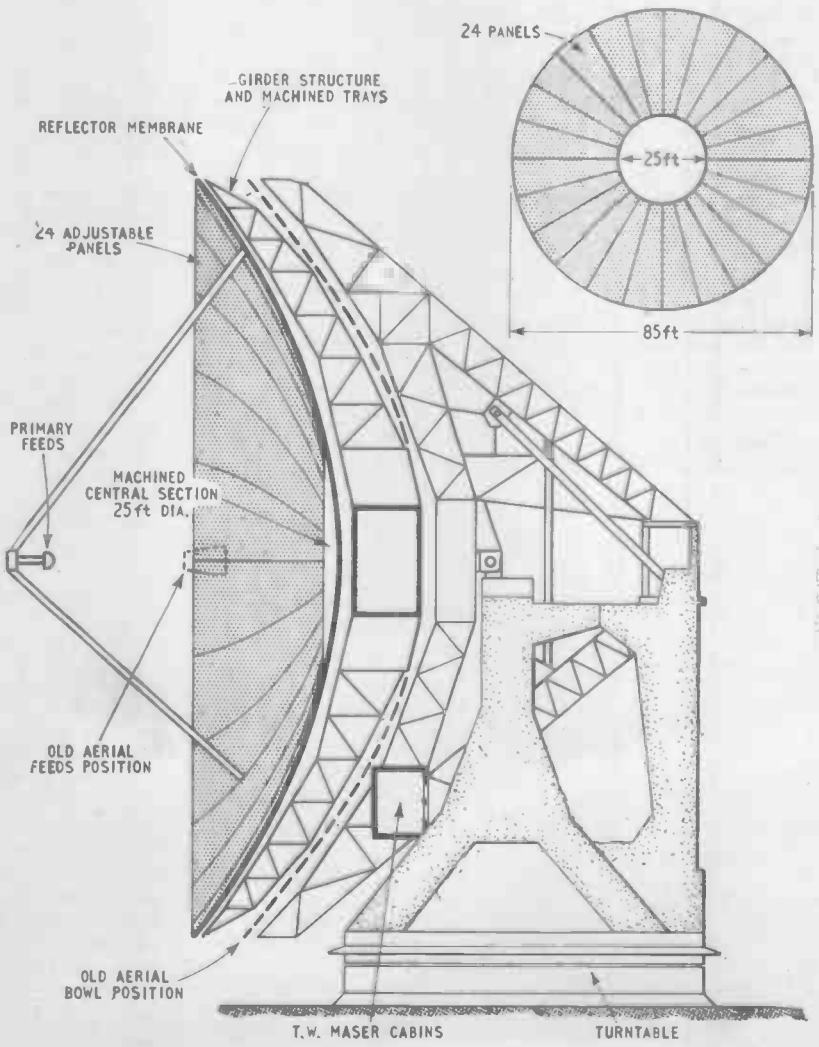


Fig. 1. Main features of the modified aerial, showing the new bowl built on top of the old one.

by the second transponder, which re-transmits them to Europe on 4.16 Gc/s. Beacon frequencies are in the region of 4 Gc/s (transmitted with e.r.p. of 250 mW) and v.h.f. telemetry frequencies are 136 Mc/s. (All figures are approximate.)

In preparation for the Early Bird communication system the British Post Office, as reported earlier, has made extensive modifications to its terminal station at Goonhilly Downs. These have been necessary mainly because different frequencies are now used and because HS-303 is more distant than earlier satellites so that received signals are considerably weaker (power received from the satellite is about 10^{-13} W). Furthermore, since the new communications system is intended for regular commercial use, it must be more reliable than an experimental scheme. The most important aspect of the modifications has been the improvement of the signal/noise ratio in the system. This has been achieved by increasing the gain of the aerial; reducing losses in the aerial waveguides; introducing a new maser receiving amplifier; and increasing the output power of the transmitter.

The higher transmitter power (8 kW) is provided by a new water-cooled travelling-wave tube with a cloverleaf slow-wave structure developed by G.E.C. and S.E.R.L. This valve, like the maser, is housed within the aerial structure.

Changes made to the aerial are illustrated in Fig. 1. To obtain more efficient transfer of energy between the primary feeds and the paraboloid reflector, the reflector bowl has been made shallower and the feeds unit moved outwards to the new focus position. As a result the aerial aperture has been reduced from 180° to 140°. The new bowl has, in fact, been built on top of the old one. Precision engineering techniques have been used to obtain high reflection accuracy. The bowl membrane now consists of a solid steel 25-ft central section, machined to an accuracy of 0.015 in to act as a reference, and 24 adjustable stainless steel panels surrounding it. The surface positions of these panels have been adjusted, against a parabolic test template, by the multiplicity of screw jacks mounted behind the membrane on the supporting structure (the bowl having been rotated under the template). As a result the bowl is within ±0.1 in of the optimum paraboloid over 99% of its surface. In addition, the feed supports have been designed and positioned to reduce aperture blocking and feed shadowing, and losses due to these effects are estimated as less than 0.26 dB. As shown in Fig. 2, these aerial modifications have sharpened the radiation pattern and increased the gain by 6 dB to 60.5 dB at 6 Gc/s.

New travelling-wave maser. A second maser will be installed later to act as a standby.

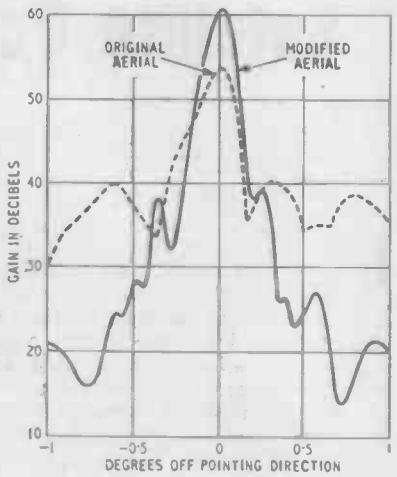


Fig. 2. Radiation pattern of new aerial compared with old one, showing improvement in gain and suppression of side lobes.

The new Mullard travelling-wave maser has a higher gain (about 7 dB more) than that of the earlier model and the noise temperature has been reduced from 15° K to about 10° K. An unusual feature of the device is the use of a light-weight superconducting electromagnet for tuning in place of the earlier heavy permanent magnet. This has improved the stability of operation of the device. The low temperature necessary for superconductivity in the magnet coils is provided by the liquid helium bath (−271°C) used for the maser.

Detection of the received signals (after they have been converted down to 70 Mc/s) is performed by an f.m. negative feedback demodulator. In this the deviation of the signal is reduced by frequency feedback before it reaches the final discriminator and the noise bandwidth is limited by a filter with a passband narrower than that of the original deviation.

As a result of the modifications the figure of merit (gain/noise temperature) of the overall system has been improved by 4 dB. Of this, 3 dB results from the better aerial performance and 1 dB from lower noise temperature.

Since Early Bird is a "stationary" satellite the aerial tracking requirements are much less stringent. The aerial bowl movement is still controlled from predicted satellite position data (sent from the U.S.A. and converted into azimuth and elevation aerial co-ordinates, by computer at Goonhilly), but the predicted data sent are now more widely spaced in time. Position interpolation is performed by the computer and the aerial control equipment, to give position-demand signals for the aerial digital servos at 1/50th second intervals. Errors in prediction are estimated at not more than 10′ arc. Fine positioning of the aerial beam, to correct errors in prediction or due to wind forces on the aerial bowl, is now performed automatically by a closed-loop control system. In this the beam is made to follow the satellite, by hydraulically powered movement of the aerial feed unit relative to the true focus of the paraboloid, in response to error signals derived from a conical-scan position-detecting system.

ELECTRONIC LABORATORY INSTRUMENT PRACTICE

By T. D. TOWERS,* M.B.E., A.M.I.E.E., A.M.I.E.R.E.

5.—MEASUREMENT OF RESISTANCE

NINE times out of ten in an ordinary electronics laboratory you will use a multimeter to measure resistance. Next time you have occasion to do such a measurement, halt that reflex reaching for the Avo, and think " What am I doing? What will the reading tell me? What accuracy can I expect?" If you think you could, *without reference to a textbook*, score more than 90% for an examination question like this, you need not read on. If, however, your ideas on resistance measurements are, like most people's, a bit hazy, you may be interested in the description given below of the variety of methods (of which the multimeter is only one) which can be used.

Multimeter Resistance Measurements

Most multimeters are provided with direct reading resistance scales. When switched to an " ohms " scale the instrument uses the basic meter movement in combination with an internal battery and resistive network to display a reading of the value of a resistance connected across its terminals.

In most commercial multimeters, the ohmmeter section is of the basic " series-type " shown in Fig. 28 (a) where the current meter M is combined internally with a voltage source, E, (usually a 1½V battery) and a series resistance RV.. The component to be measured is connected across the test terminals X-X and its resistance is read off on an ohms scale on the meter.

In practice, the operation is self-calibrating. First you leave the test terminals open, and verify that the meter scale reads zero deflection (infinite resistance). You may have to adjust the meter-preset screwdriver zero-adjustment for this. Then you short-circuit the test terminals and adjust the " zero-ohms " knob (controlling RV) until the meter reads full deflection (zero ohms). Next you connect the unknown R between the test points X-X and read its resistance on the direct-reading resistance scale. The scale (which normally reads forward from left to right for increasing current or voltage) reads backward for increasing resistance, since the current through M falls as the resistance across the test terminals increases. The resistance scale is non-linear, being crowded up towards the left-hand (high resistance) end.

Good commercial multimeters, like the Salford " Selectest," or the Avo Model 8, described in previous articles, have three switched resistance ranges. In these the normal range ($\Omega \times 1$) measures 0-200kΩ, with 2kΩ mid-scale; the high resistance ($\Omega \times 100$) measures 0-20MΩ, with 200kΩ mid-scale; the low resistance ($\Omega \div 100$) measures 0-2000Ω, with 20Ω mid-scale.

How accurately does a multimeter read resistance? When it leaves the manufacturer, the accuracy specification (for example, of the " Selectest ") is typically $\pm$ 3% from zero to mid-scale, $\pm$5% from mid-scale to 2/3rd full scale and $\pm$10% from 2/3rd up to full scale. After a few " adventures " in the lab., you would be unwise to assume that it is as good as this. If you are prudent you should not rely on its being better than 5% below mid-scale, 10% from ⅓ to 2/3rd scale, and 20% to 2/3rd to full scale.

These accuracies are sufficient for many requirements in the laboratory but you may want to check more closely on occasion. You can then turn to one of the more specialized instruments described later. Alternatively (and this is very often done) you may check the multimeter resistance range error by measuring a standard cracked-carbon high-stability resistor of known value. These can be obtained quite cheaply to a 1% tolerance

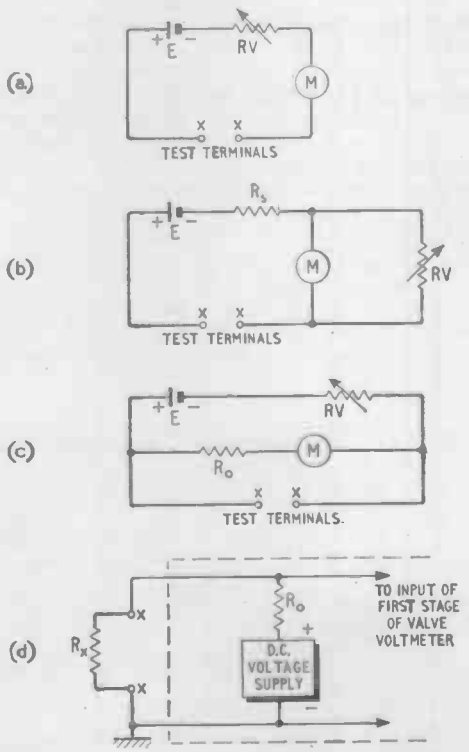


Fig. 28. Basic circuits for resistance measurement: (a) series-type ohmmeter range of multimeter; (b) alternative series-type ohmmeter (c) shunt-type ohmmeter; (d) valve-voltmeter circuit for measuring resistance.

* Newmarket Transistors Ltd.

from your usual electronics supplier or in case of difficulty from specialist firms such as the Radio Resistor Co. Ltd. With a range of these (say 1Ω, 10Ω, 100Ω, up to 1MΩ) you can rapidly check the multimeter resistance scale in the area of resistance where you are critically interested, and apply the necessary correction to your reading of the unknown. A useful tip is to keep the resistances handy in a polythene bag Sellotaped to the top of your instrument.

In using the multimeter as an ohmmeter, remember the few simple precautions following:—

(a) Before commencing test, adjust meter zero-deflection if necessary by screwdriver meter-zero adjustment control.

(b) Check that connections to test terminals are tight.

(c) Check that meter is switched to correct resistance range.

(d) Short-circuit test prods or terminals and adjust full-scale deflection (for zero resistance) with the "set-zero" control knob.

(e) Verify that in short-circuit test, (d), the meter pointer does not "wander" or "jitter"—this indicates a nearly exhausted internal battery. If you cannot bring the pointer up to full-scale deflection at all, renew the battery.

(f) Don't leave a resistor (or short-circuit) across the terminals except in making measurements, as this may run the battery down.

(g) After use, *always* switch away from the resistance range (preferably to a high voltage one).

(h) Remember that without calibration check against a standard, errors as high as ± 20% can occur at some points of the scale in practice.

Variants of the basic series-type ohmmeter circuit of Fig. 28 (a) may be met with. For example, another version of the series circuit is given in Fig. 28 (b). Here the short-circuit adjustment for full-scale meter deflection is made by a variable resistor RV in parallel with the meter. However, the basic principle of measuring an external resistance connected across the test terminals X-X by measuring the current through it (and an internal resistance in series with it) still obtains.

A different principle is adopted in the shunt-type ohmmeter circuit of Fig. 28 (c) where, on open circuit, the meter is adjusted by RV to full-scale deflection. When a resistance is connected across the terminals X-X, the current through the meter falls to indicate the resistance. This type of ohmmeter reads increasing resistance from left to right, the opposite way to a series ohmmeter, and is less common.

Valve Voltmeter Resistance Measurements

After the multimeter, the commonest instrument used for resistance measurements in an electronics laboratory is the general-purpose valve voltmeter, which now usually incorporates resistance as well as voltage measurements.

Fig. 28 (d) illustrates the basic arrangement of the valve voltmeter in its resistance ranges. Current from the internal d.c. voltage supply flows through an internal precision resistor R_o and the unknown resistance R_x connected across the test terminals X-X. The resultant potential difference across R_x is applied to the input stage of the valve voltmeter, which gives a corresponding pointer deflection. The higher the unknown resistance R_x, the greater the deflection. The resistance scales of a valve voltmeter thus read from left (low resistance) to right (high resistance) in contrast to the multimeter which, as we saw above, reads the other way round.

The valve voltmeter ohmmeter tends to cover a wider range of resistance than the multimeter—and in a greater number of switched ranges. For example, the KLB Paco V70 valve voltmeter has seven switched resistance ranges covering 0-1000Ω (10Ω midscale), 0-10,000Ω (100Ω midscale) etc. up to 0-1,000MΩ (10MΩ midscale). This contrasts with the three internal ranges of the Avo with a 20MΩ maximum. The difference is not so great, however, when the valve voltmeter is transistorized. In the typical good transistorized voltmeter illustrated in Fig. 29, the B.P.L. TVM1063, the resistance ranges available are 0-1MΩ, 0-10MΩ, 0-100MΩ. (Unlike the more conventional valve voltmeters, the resistance scale on this particular instrument reads from right to left like a multimeter.)

The precautions outlined earlier for using the multimeter in resistance measurements apply equally to valve voltmeters, which are provided with the same zero-setting facilities.

Bridges for Resistance Measurements

In the higher resistance ranges, the valve voltmeter is capable of measuring resistances with an accuracy better than the multimeter, but otherwise its accuracy is still only of the order of 5% or so. For better accuracies

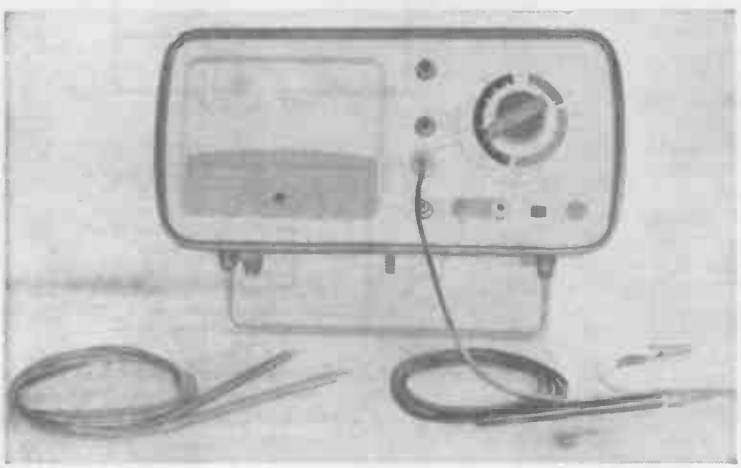


Fig. 29. Typical commercial valve voltmeter with three resistance ranges 15kΩ, 150kΩ, 15MΩ midscale reading (B.P.L. TVM 1063, transistorized).

you must turn to some other measurement method. Now the well-known Wheatstone bridge has been in use since the earliest days of electricity to make accurate resistance measurements and it still finds wide use in ordinary electronic laboratories.

The original Wheatstone bridge for d.c. measurement of resistance, from which many different bridge types have evolved, is shown in basic form in Fig. 30(a). Here E is the d.c. source voltage, A, B and S are the selected bridge resistors; and R_x is the unknown external resistor. The bridge resistors are adjusted until depressing the key produces no deflection in the galvanometer or current meter, M. At balance, it can be shown that

$$R_x = \frac{A}{B} \cdot S$$

The two internal bridge arms A and B in Fig. 30(a) are known as the " ratio arms ". In commercial instruments the ratio of these is selected by switches so that the third arm S (known as the " series " arm), a dial-controlled variable, will yield the maximum number of significant figures.

For low resistances of the same order as the bridge contact and lead resistances, the Kelvin bridge, a modified form of the Wheatstone bridge, is often used. The basic Kelvin bridge circuit is given in Fig. 30(b). In this, B and S are chosen large compared with lead and contact resistances. R_x can then be measured accurately even if it is very low. When the bridge is balanced with b/B = s/S, it can be shown that $R_x = \frac{A}{B}.S$ as before.

For very high resistances, again the accuracy of measurement on a standard Wheatstone bridge falls off, mainly due to lack of a sufficiently sensitive null detector meter, M. The Wheatstone configuration has, however, been used to measure resistance of the order of 1,000,000 MΩ. For this the meter null detector is replaced by a highly sensitive valve detector as shown in Fig. 30(c). A guard ring is used so that leakage across the insulation of the high resistance arm, A, of the bridge does not affect the balance point.

The balancing of d.c. bridges is not difficult, but one precaution it is wise to take is to confirm that the balance is obtained at the same point on the resistance dial when the polarity of the bridge energizing voltage is reversed.

Up till now we have dealt with a d.c. Wheatstone bridge where the source is d.c. from a battery, and the detector a centre-reading galvanometer or meter. Now laboratories also normally require a bridge for impedance measurements (to be discussed in the next article) and this calls for some form of a.c. bridge. If the signal source of the d.c. Wheatstone is changed to an a.c. oscillator and the detector to an a.c. detector (such as a pair of headphones or an a.c. voltmeter), we get a bridge capable of measuring impedances. At low audio frequencies, a " resistance " normally has negligible reactance, so that it is possible to use an l.f. a.c. bridge for " d.c." resistance measurement. The basic circuit of the a.c. Wheatstone bridge is given in Fig. 30(d). If the frequency of the a.c. source is low (50-2000c/s) and the bridge impedances Z_A, Z_B, Z_S as well as the unknown Z_x are effectively resistive then the balance equation becomes, as with the d.c. bridge, $R_x = (A/B)S$.

The a.c. bridge circuits used in commercial l.f. bridges are not often simple Wheatstone types but usually one of the many derivative types, which are beyond the scope of this treatment. Interested readers might well consult E. Hague "Alternating Current Bridge Measurements " (Pitman) where over 100 bridge types are described.

The range and accuracy of resistance measurement

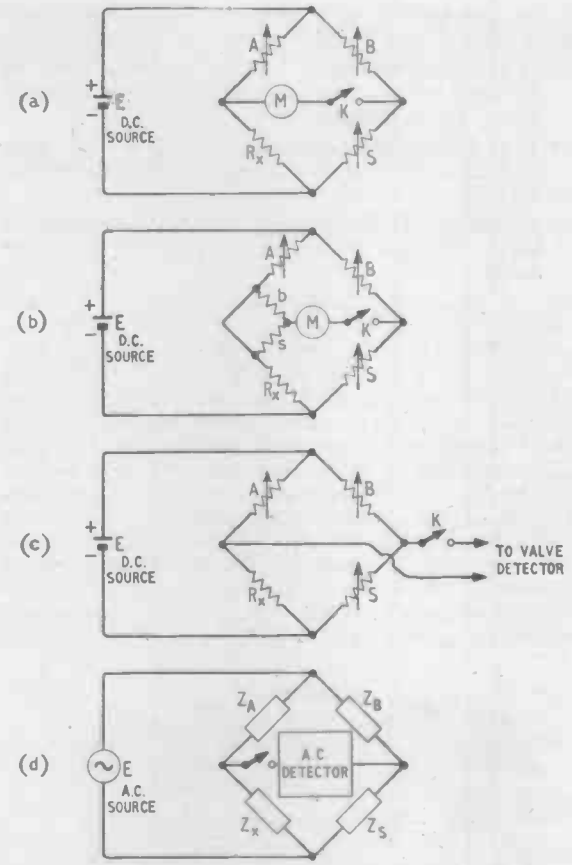


Fig. 30. Basic bridge circuits commonly used for resistance measurements: (a) d.c. Wheatstone; (b) d.c. Kelvin; (c) amplified d.c. Wheatstone; (e) a.c. Wheatstone.

Fig. 31. Typical commercial example of portable Wheatstone d.c. bridge (W. G. Pye 7383).

with the three types of d.c. bridges described for general purpose instruments is approximately as follows:

(a) **D.C. Wheatstone** 1-1,000,000 ohms with an accuracy of the order of ± 0.1% (can be obtained down to ± 0.003%).

(b) **D.C. Kelvin (low resistance)** down to 0.001 ohm with accuracy of the order of ± 0.1% except for very low values of resistance.

(c) **Amplified D.C. Wheatstone (high resistance)** up to 10^{12} ohms with accuracy of ± 4% up to 10^{10} ohms.

Fig. 31 illustrates a widely used example of a d.c. resistance bridge, the W.G. Pye type 7383 Portable Wheatstone. Capable of measurements from 0.001Ω to 1MΩ. this bridge has a built-in pointer galvanometer and a 4½V internal battery for applications where full portability is required. However, terminals are provided for an external galvanometer and external battery for ultra precise measurements in the laboratory. The series arm comprises four decades in steps of hundreds, tens, units and tenths of ohms, and uses manganin coils adjusted to ±0.02% accuracy, except the 0.1 ohm coils which are adjusted to ±0.2% accuracy. The two ratio arms are each switched selections of 1, 10, 100 and 1000 ohms utilizing manganin coils adjusted to ±0.01% accuracy. Other well-known names in the d.c. bridge field are

Fig. 32. Typical commercial example of portable a.c. bridge capable of accurate measurement of resistance, as well as impedance (Marconi TF2700—transistorized).

Baldwin, B.P.L., Cambridge Instruments, Croydon Precision, Sullivan, Tinsley and Wayne Kerr.

In the lab. you will often find that the l.f. a.c. bridge is used for rapid resistance measurements when accuracies better than the multimeter or valve voltmeter are looked for, and the high accuracy obtainable with the slower-operating Wheatstone is unnecessary. An excellent example of this type of bridge is the Marconi TF2700 illustrated in Fig. 32. This is a new-generation transistorized universal bridge, designed to measure L, C and R, but eminently suitable for rapid, accurate resistance measurements. The internal battery-powered transistor oscillator provides a bridge source at 1kc/s. The TF2700 has eight resistance ranges in decades from 0-1·1Ω to 0-11MΩ. In all ranges except the bottom one, the measurement accuracy is better than ±1% of the reading added to ±0.1% of the range maximum. On the bottom 1.1Ω range, the accuracy is ±2%, ±0.1% of range

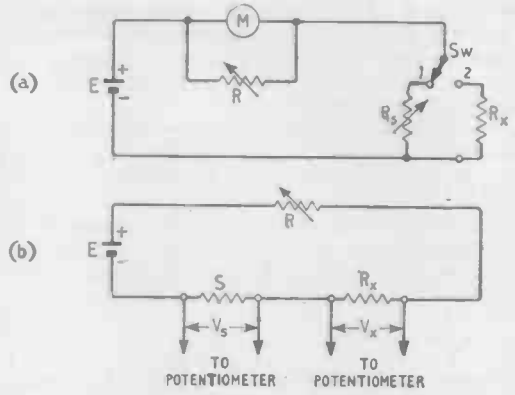


Fig. 33. Basic circuits for high-accuracy resistance measurement by: (a) substitution; (b) potentiometer.

maximum. As a general statement it can be said that the accuracy is about 1%. The TF2700 is tending to take over from the well-known TF868 valve universal 1% LCR bridge which has been " a piece of the furniture " in so many electronics laboratories over the last decade. A.C. bridges suitable for resistance measurement will be covered more fully in the next article.

Substitution Measurement of Resistance

A simple " lab. lash-up " method for resistance measurement that can be of considerable accuracy employs the circuit of Fig. 33(a). A battery E is connected via a galvanometer or meter M with a variable shunt resistor R to a switch S. The resistance R_s is a variable standard resistance, and R_x the unknown. With the switch in position 2 the meter current is adjusted to a convenient deflection by means of the variable shunt resistor R. S is then switched to position 1, and R_s adjusted to give the same current reading. At this point $R_s = R_x$. The precision of the method depends on the accuracy of R_s and of the meter scale reading, and can be high if R_x

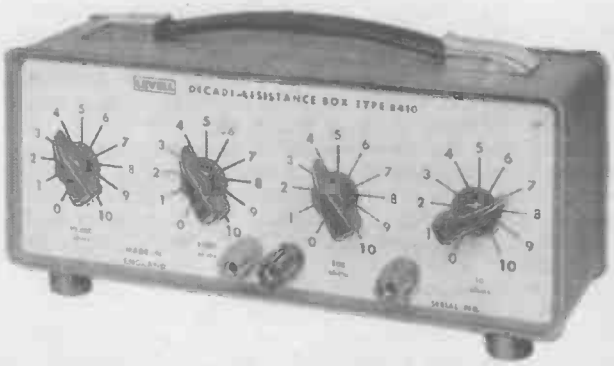


Fig. 34. Typical commercial decade resistance box for use in methods of Fig. 33. (Levell type R410).

is large compared with contact and lead resistances.

In Fig. 33(a) the " substitution " resistor R_s is usually a "decade resistance box". This is a useful piece of general purpose laboratory equipment, which can vary from expensive 0.01% accuracy to economical 1% accuracy.

Usually it has four decades of resistors selectable by switches. Typical of the 1% variety is the Levell Type R410 decade resistance box illustrated in Fig. 34. This particular version can switch-select any resistance from 10 to 111,100 ohms with $\pm 1\%$ accuracy. In decade boxes, you are likely to meet units manufactured by such companies as Baldwin, Cambridge Instruments, Croydon Instruments, Daystrom (Heathkit), Furzehill, Rivlin, Sullivan and W. G. Pye.

Besides resistance boxes, most of the firms specializing in d.c. resistance test equipment supply single standard resistances of various degrees of accuracy from 0.001% to 1%.

One feature of the circuit of Fig. 33(a) calls for remark. When you are using a decade resistance box for R_x, watch out that you do not put too much current through it. The high stability resistors in the box are very liable to lose their accuracy if overloaded. Read the instruction leaflet or manual for the decade box very carefully, and ensure you do not exceed the manufacturer's current rating. If you should do so by accident, immediately tie a label to the box saying what has happened. This prevents the next user from placing unjustified reliance on the accuracy of the standard until calibration check has been possible.

Potentiometer Method of Measurement

Another lab. bench method of measuring resistance is by means of a potentiometer as illustrated in Fig. 33(b). The potentiometer, which was described in the February, 1965, article of this series, is used to compare the voltage drop, V_x, across the unknown R_x with that, V_s, across a standard resistance, S. It can be shown easily that

$$R_x = \frac{V_x}{V_s} . S$$

The measurement must ensure that the current through both resistors is constant. Usually a decade resistance standard box is used for S, and adjusted until the potentiometer reads the same voltage when switched repeatedly from R_x to S and back. This makes the method rather tedious but it has the advantage that the unknown can be evaluated very accurately in terms of a suitably chosen standard. This method is capable of extremely high accuracy if a sufficiently good potentiometer and reference resistance standard are used.

Fig. 35. Typical commercial high-resistance megohmmeter (W. G. Pye 11801 Wide Range Megohmmeter, 3MΩ to 200 million MΩ).

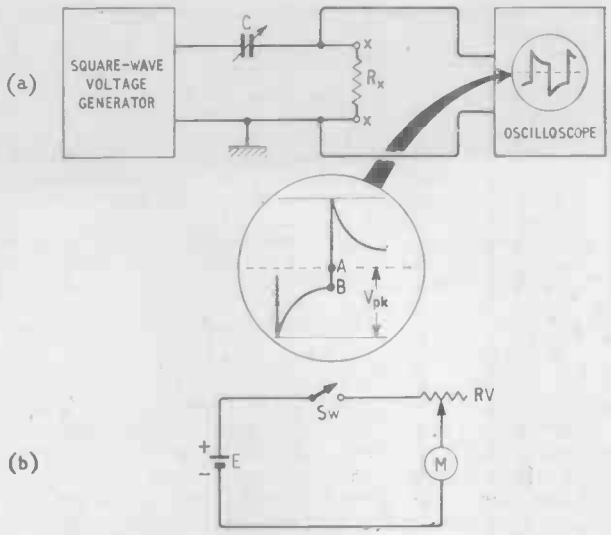


Fig. 36. Basic circuits of miscellaneous resistance measuring techniques: (a) oscilloscope trace decrement method; (b) meter internal resistance measurement by variable resistance.

Low Resistance Measurements

Several of the methods outlined above are useful in the very low resistance field. In particular the Kelvin bridge is very commonly used. Some firms make equipment specially for low resistance measurements, as, for example, Startronic with their " Lohmeter " and " Milohmeter ".

A particular problem arises when you are measuring switch contact resistances. You may get variable and misleading results if you do not ensure that sufficient voltage is applied to break down surface oxide layers in the switch.

High Resistance Measurements

High resistance measurements have been discussed generally under the various methods outlined earlier. Again some firms specialize in this field. Most electrical engineers for example, will know of the portable " Megger " type ohmmeter manufactured by Evershed and Vignoles. In electronics laboratories, while the Megger is not uncommon, it is more usual to find more specialized static equipment used if any substantial high resistance measurements are required.

Typical of these specialized high resistance test sets is the W. G. Pye 11801 Portable Wide Range Megohmmeter illustrated in Fig. 35. This covers 3 megohms to 200 million megohms in seven switched ranges. Battery operated, it provides a constant test potential of 500V, and comprises a highly stabilized transistor converter, a range of reference resistors and an accurate transistorized voltmeter. It is particularly suited to measuring capacitors or long cables, and is fitted with a guard terminal to minimize the effect of leakage paths.

Miscellaneous Techniques

One technique of resistance measurement I myself have been working with recently, which has considerable

JUNE ISSUE

Publication date of the June issue of *Wireless World*, which will include a preview of the London Radio and Electronic Component Show, will be brought forward to May 17th, the day before the exhibition opens at Olympia. The Show, sponsored by the Radio and Electronic Component Manufacturers' Federation, will open daily from 10 a.m. to 6 p.m. from May 18th to 21st. The preview will summarize briefly some of the 250 exhibitors and will be in addition to the normal quota of articles and regular features.

potential (but is not at present in common use), is the "square wave", or what I call the "scope trace decrement", method. The basic circuit of this is illustrated in Fig. 36(a) where a square-wave generator with output impedance negligible compared with the resistance R_x to be measured is used to drive the differentiating network, CR_x. The wave shape across R_x is inspected with an oscilloscope (with input impedance high compared with R_x). The capacitor C is adjusted until the step "AB" at switch-over on the scope trace is 4.3% of its negative peak value V_{pk}. It can be shown then that $R_x = 1/(2\pi f_o C)$, where f_o is the square wave repetition rate.

A common practical problem in a laboratory is to measure accurately the internal resistance of a d.c. milliammeter or microammeter, particularly when you want to select a shunt or series resistor to attain a specific full scale deflection. There are many ways of doing this, but the commonest (and easiest) is probably the variable resistor method shown in Fig. 36(b). This uses a calibrated variable resistance RV (which can be a decade resistance box) and a *steady* d.c. voltage source E (for example a *fresh* 1.5V battery) to test the resistance of the meter M. To make the measurement you close the switch and adjust RV until the meter reads full scale. Let RV_o be the value of RV for this. Now increase RV until the meter reads half-scale. Let RV value now be RV_1. The meter internal resistance can then be found from $R_M = RV_1 - 2RV_o$. The accuracy of your result depends on how precisely the mid-scale point on the meter represents half current and on how accurately you can measure RV_o and RV_1. At a pinch you can use a volume control potentiometer for RV, and measure the values at the two settings with an Avo, or, better, a resistance bridge.

Summary

When you have to make resistance measurements, always try to use the best instrument available for the resistance range and accuracy you are interested in. In broad terms,

(a) For accuracies of the order of 10% and not too low or too high resistances, you can use a multimeter or valve voltmeter (but take the precaution of checking it with standard resistances occasionally).

(b) For accuracies of the order of 1% you can usually employ a good l.f. a.c. bridge or a general-purpose d.c. bridge.

(c) For accuracies of the order of 0.1% or better, you must turn to specialist instruments such as refined d.c. bridges.

To return to my original question, you should now be in a position to realize how and with what accuracy an Avo measures resistance. As most run-of-the-mill circuitry works with only 5% or 10% tolerance resistors, and a good well-calibrated multimeter can measure to this accuracy, you can also see why more than nine times out of ten engineers in an electronics laboratory reach for the multimeter, already on their bench, to check a resistor value.

This Month's Conferences & Exhibitions

Further details are obtainable from the addresses in parentheses.

LONDON

May 17-21 — Savoy Place
Components & Materials used in Electronics Engineering
(I.E.E., Savoy Place, W.C.2)

May 17-21 — Grosvenor House, W.1
International Instrument Show
(B. & K. Laboratories, 4 Tilney St., W.1)

May 18-21 — Olympia
Radio & Electronic Component Show
(R.E.C.M.F., 6 Hanover St., W.1)

May 20-21 — R.Ae.S., Hamilton Place, W.1
Electrical Conduction at Low Temperatures
(Inst. Phys. & Phys. Soc., 47 Belgrave Sq., S.W.1)

DUNDEE

May 25-27 — Marryat Hotel
Electronics in Action Exhibition
(I.E.E. Scottish Electronics & Measurement Section, 50 Holeburn Rd., Glasgow)

EASTBOURNE

May 13 & 14 — Grand Hotel
New Materials & Processes in Instrument Manufacture
(Scientific Instrument Research Assoc., Chislehurst, Kent)

SCARBOROUGH

May 24-27 — Royal Hotel
R.T.R.A. Annual Conference
(Radio & Television Retailers' Assoc., 19 Conway St., W.1)

OVERSEAS

May 5-7 — Clearway, Fla.
Microwave Theory & Techniques
(J. E. Pippin, Sperry Microwave Electronics Corp., Box 1828, Clearway, Fla.)

May 6-8 — Boston
Human Factors in Electronics
(I.E.E.E., Box A, Lenox Hill Station, New York 21, N.Y.)

May 10-12 — Dayton
Aerospace Electronics Conference
(NAECON, 1414E, 3rd St., Dayton 2, Ohio)

May 19-25 — Amsterdam
Electronic Exhibition
(Elvabé, Molenallee 63A, Wilp, Gld., Netherlands)

May 24-28 — Montreux
Television Symposium
(R. Jaussi, Postfach 97, Montreux, Switzerland)

May 24-29 — New York
Information Processing Conference
(British Computer Soc., Finsbury Pavement, London, E.C.2)

May 25-27 — Washington
A.F.C.E.A. Annual Convention
(Armed Forces Communications & Electronics Assoc., 1725, Eye St., N.W., Washington, D.C.)

MAY MEETINGS

Tickets are required for some meetings: readers are advised, therefore, to communicate with the society concerned

LONDON

3rd. I.E.E. Graduates & Students.—"Some aspects of transistor tape recorder design" by Dr. J. C. Vickery at 6.30 at Savoy Place, W.C.2.

6th. Royal Society.—"The organization of a memory system" by J. Z. Young at 4.30 at Burlington House, Piccadilly, W.1.

11th. I.E.E.—Colloquium on "Semiconductor capacitors in varactor and pulse applications" at 2.30 at Savoy Place, W.C.2.

12th. I.E.E.—"Television recording" by P. Leggatt at 5.30 at Savoy Place, W.C.2.

12th. I.E.E. & I.E.R.E.—"Random access mass stores" by J. Davey at 6.0 at the London School of Hygiene & Tropical Medicine, Keppel Street, W.C.1.

13th. I.E.E.—"Effect of weather on performance of 8mm radar" by O. Nourse and S. G. Nicholls at 5.30 at Savoy Place, W.C.2.

19th. I.E.R.E.—"A groove control system for phonograph disk cutting equipment" by H. Lindskov Hansen at 6.0 at 9 Bedford Square, W.C.1.

21st. Inst. of Navigation.—"A satellite/ground station navigational aid" by R. E. Anderson at 4.30 at the Royal Instn. of Naval Architects, 10 Upper Belgrave St., W.1.

26th. I.E.R.E.—"The impact of electronics on the Army's repair organization" by Major General L. H. Atkinson at 6.0 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

CAMBRIDGE

4th. I.E.E.—"Anglo-Canadian transatlantic telephone cable" by F. Scowan at 6.30 at the College of Arts & Technology.

MIDDLESBROUGH

5th. I.E.E.—"Fuel cells, a branch of electrochemical engineering" by Dr. A. B. Hart, at 6.30 at Cleveland Scientific Instn.

PRESTON

5th. I.E.E.—"Computers" by Dr. R. Feinberg at 7.30 at the Harris College.

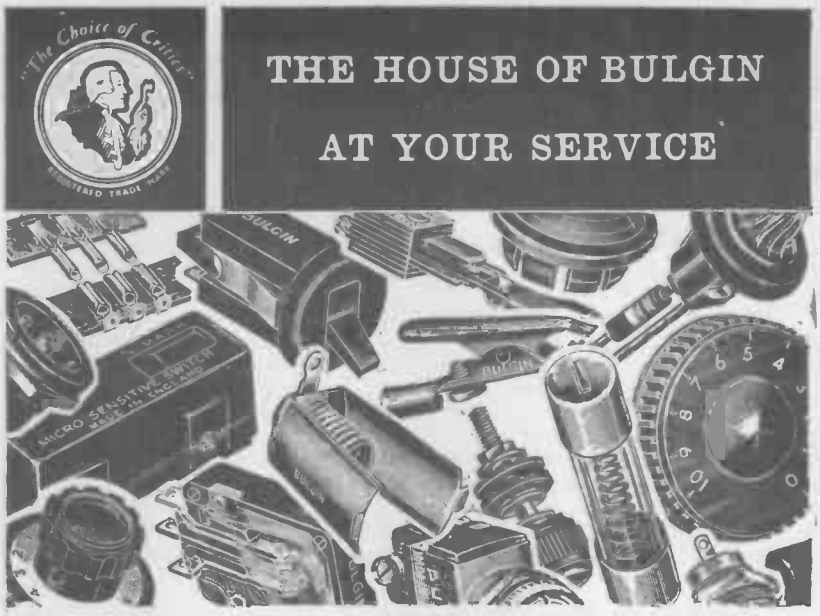
CLUB NEWS

Bexleyheath.—Mobile operation will be discussed at the meeting of the North Kent Radio Society on May 13th at 7.45 at the Congregational Church Hall.

Heckmondwike.—Members of the Spen Valley Amateur Radio Society are to visit the Wharfedale Wireless Works at Idle, Bradford, on May 13th. A fortnight later at 7.30 at the Grammar School, H. Tomlinson, of the G.P.O., will discuss communication via earth satellites.

Leamington Spa.—The May programme of the Mid-Warwickshire Amateur Radio Society includes lectures on single sideband reception (3rd), amateur aerial arrays (17th) and the fifth of a series on radio theory (31st). Meetings are held at 7.45 at Harrington House, Newbold Terrace.

Portsmouth.—The Royal Naval Amateur Radio Society is holding a mobile rally at H.M. Signal School—*H.M.S. Mercury*—near East Meon, Hants, on May 30th. Talk-in station GB3RN will operate on 1.88, 70.26 and 144.2 Mc/s and station G3BZU on 3.72 Mc/s for s.s.b. operators. Further particulars from M. J. Mathews (G3JFF) *H.M.S. Mercury*, Leydene, Petersfield, Hants.



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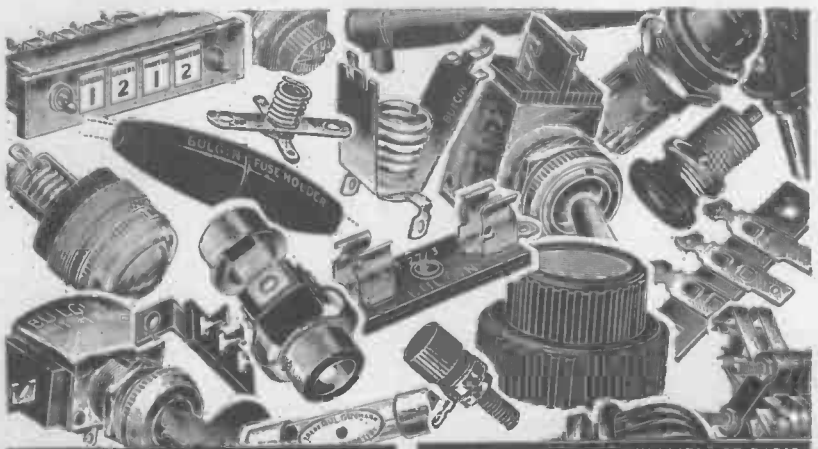

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LOGIC CIRCUITS

THE second I.E.E. & I.E.R.E. Joint Colloquium on logic circuits early this year was well attended (more than 500 were present) and logic circuit design engineers will no doubt continue to present themselves *en masse* at future meetings, which are expected to be held annually.

As switching times are gradually decreasing the problem of interconnections assumes greater proportions, and engineers must give greater consideration to the design of logic elements driving interconnections. Considering interconnections as transmission lines,* propagation delay will be in the order of 2nsec per foot with normal materials and the characteristic impedance will be about 50-300Ω. Thus elements at each end of interconnections must be matched to this impedance if ringing due to reflections is to be minimized, and logic voltage levels must be kept low in order to keep dissipation within reasonable limits. Line-driver circuits were discussed, including a commercially available type with a 2 nsec edge speed.

Some aspects of a balanced 50 Mc/s tunnel diode circuit (Goto Pair) were considered. Here interconnection limitations are severe and in one realization described intermodule connectors were limited to 5in. The impedance of the connections was controlled by interleaving the printed interconnections with earth planes. At speeds of 250 Mc/s, where a maximum permissible length is about 1in, it becomes necessary to use delay lines in interconnections but these do not affect the repetition rate of the system.

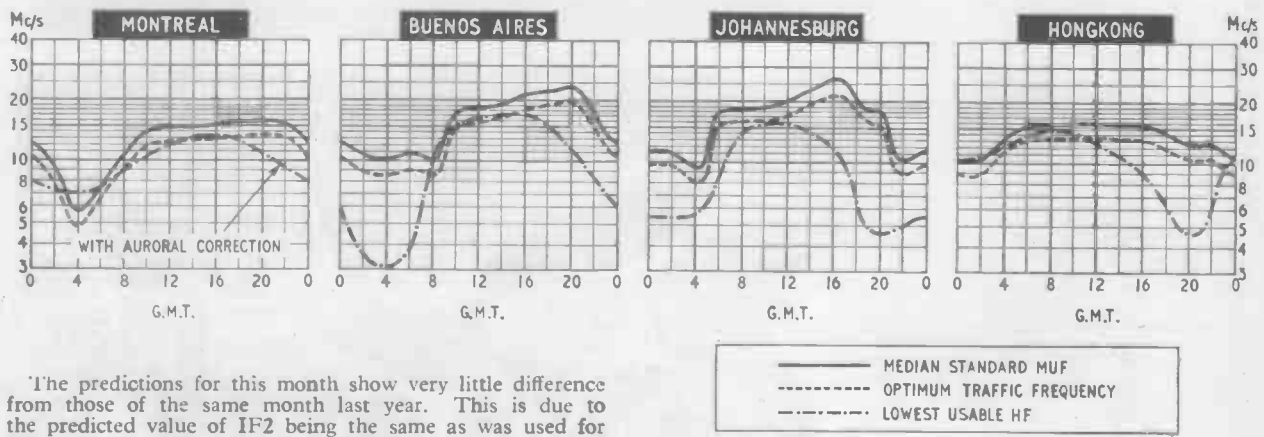
Faster switching times in diodes are realized by shortening carrier storage time and this is achieved in the metal semiconductor diode or hot-carrier diode. But development of the related metal-base transistor is not sufficiently advanced to offer a challenge at the moment to tunnel diode switching times. (A metal-base transistor with a theoretical limit of 20 Gc/s was described at the 1964 Electronic Component Conference, U.S.A.)

Attention was drawn to the fact that a minimal logic design did not necessarily result from a minimal Boolean expression (particularly from the aspect of maintaining a minimum number of interconnections). In realizing a function involving $\bar{A}$, for instance, in AND/OR logic, any one of the following six functions may be used in place of $\bar{A}$: $\bar{A}\bar{B}$, $\bar{A}\bar{C}$, $\bar{A}(\bar{B}+\bar{C})$, $\bar{A}(\bar{B}+C)$, $\bar{A}(B+\bar{C})$ and $\bar{A}B\bar{C}$. The function $A\bar{B} + \bar{A}B$, for instance, can be realized from A, B, $\bar{A}$, $\bar{B}$, using five gates, but if $\bar{A}\bar{B}$ is formed and used in place of $\bar{A}$ and $\bar{B}$, only four gates are required. Similarly, a full adder of 12 modules is reduced to 8 modules.

The brief survey of fluid logic must have surprised some when it was stated that a liquid logic element in moulded plastic capable of switching 1-10 watts and measuring 1½in. was available off the shelf in the U.S.A. Military requirements have resulted in the availability of a range of fluid devices which can handle from milliwatts to kilowatts and with temperature ranges from −100° to 1000°F. At present, however, logic speeds are limited to around 10 kc/s.

* Detailed analyses are contained in *I.R.E. Transactions on Electronic Computers*, August and October 1963.

H. F. PREDICTIONS — MAY



The predictions for this month show very little difference from those of the same month last year. This is due to the predicted value of IF2 being the same as was used for last year. However, the value of IF2 is expected to rise, throughout the year, now that sunspot minimum has been passed. It is to be hoped that by July, conditions will be similar to those experienced in the same period in 1963.

The prediction curves show the median standard MUF, optimum traffic frequency and the lowest usable frequency (LUF) for reception in this country. Unlike the standard MUF, the LUF is closely dependent upon such factors as transmitter power, aerials, and the type of modulation. The LUF curves are those drawn by Cable and Wireless Ltd. for commercial telegraphy and assume the use of transmitter power of several kilowatts and aerials of the rhombic type.

Note that the solid line represents the median maximum usable frequency. This means that communication will be possible for only 50% of the time at this frequency. For a higher grade of service, a frequency some 15% lower should be used.

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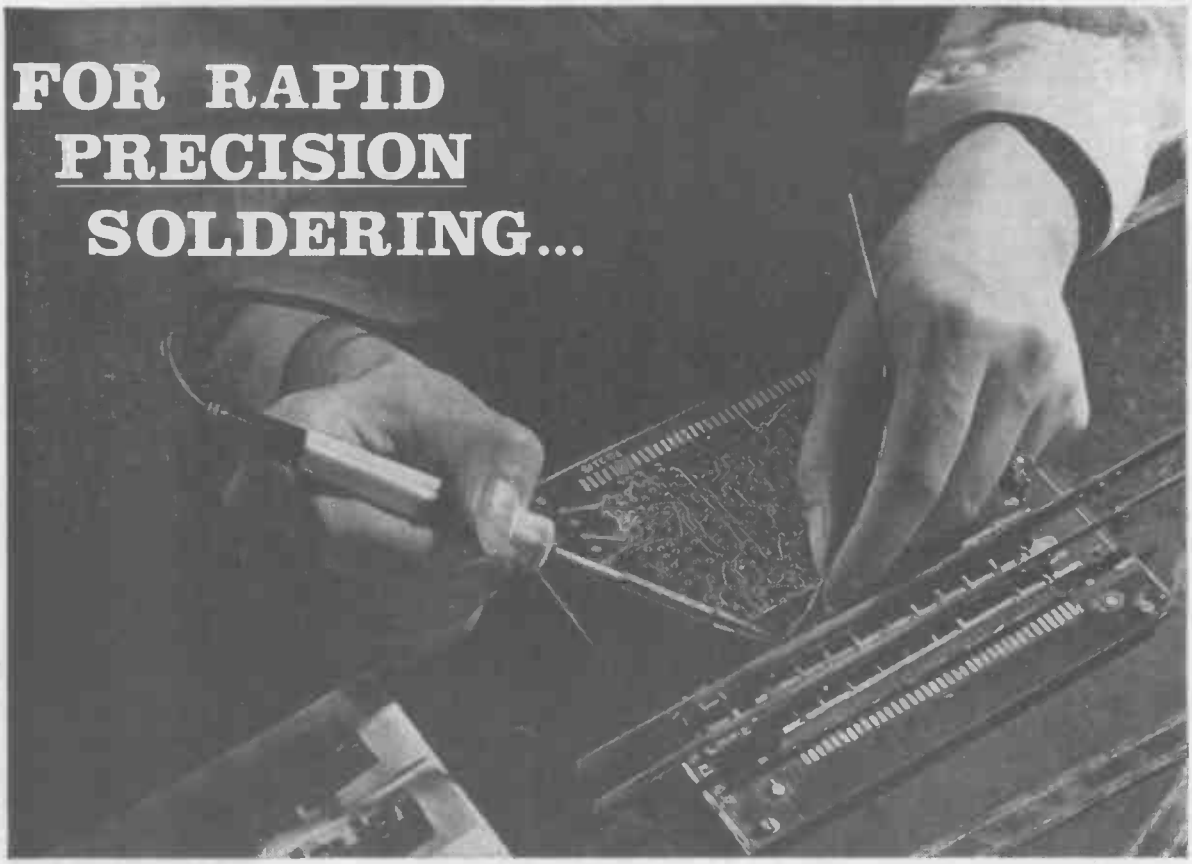

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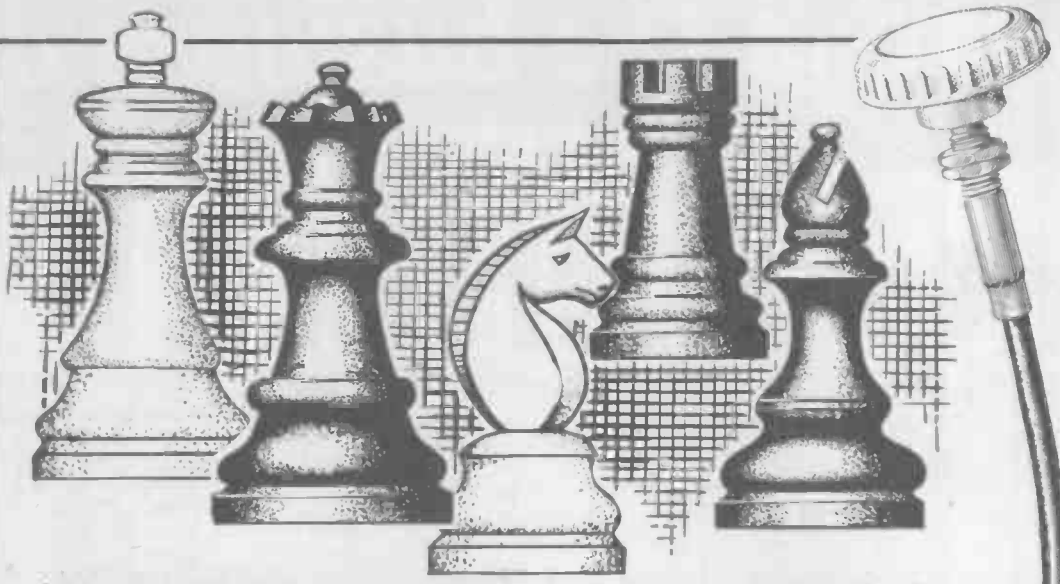

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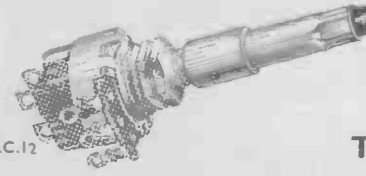

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8in. H.F.812	12,000 gauss	£3 16 6
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T816	16,000 gauss	£5 19 3
T12 tweeter	16,000 gauss	£13 17 9
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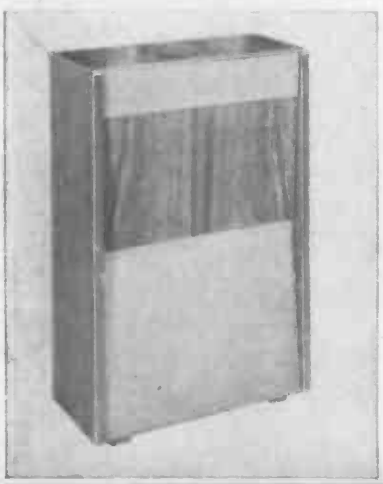

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Slim-Line Cabinet	31in.	20in.	9½in.	£10 5 0	£10 10 0

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This enclosure has been designed to accommodate any of the Stentorian range of 8 in. or 10 in. units. Provision is made for the addition of either pressure or cone type tweeter and a crossover may be used.

WHITELEY ELECTRICAL RADIO CO. LTD
MANSFIELD · NOTTS
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It's a difference of quality, often not visible until you look at performance data. Keyswitch miniature and sub-miniature relays are exhaustively tested .... each one individually. All conform precisely to a very fine specification. Their reliability is proven — they come from the makers of the C.E.G.B. approved plug-in P33 B.P.O. relay. They have all the benefits of Keyswitch delivery — and that's quick, every time.

TYPE 1051 Illustrated approx. actual size. Inexpensive sub-miniature switch relay. Snap action contacts rated to 7.5A or 480V a.c./250V d.c. Coil voltages (d.c.) 6V, 12V, 24V, 48V ±20%. This relay can cost as little as 7/5.

TYPE 1051P Illustrated approx. actual size. Snap action contacts rated at 3.5A, 250 a.c., 100MA and 100V d.c. Metal can-type cover and complete with octal socket. This relay can cost as little as 10/6.

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Transistorised REGULATED POWER SUPPLY Model IP-20U

Tremendous value! 0.5-50 volts D.C. output at up to 1.5 A. Voltage or current monitored on easy-to-read meter. Adjustable current limiter.

Relay protected against overload. Less than 150 microvolts ripple. Regulation less than ± 15 millivolts. Output impedance less than 0.1 ohm. Compact 9½in x 6½in. x 11in. Weight 11lb. net. Full details on request.

Kit .....£35.8.0 Assembled £47.8.0.

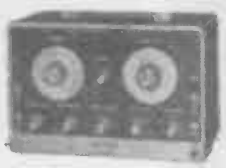
5in. Flat-face GENERAL PURPOSE OSCILLOSCOPE Model 10-12U

An outstanding new 'scope

"Y" sensitivity 10 mV. r.m.s. per cm. at 1 kc/s, bandwidth 3 c/s.-4.5 Mc/s. Frequency compensated input attenuator X1, X10, X100. T/B. 10 c/s.-500 kc/s. in 5 steps. Two extra switch selected pre-set sweep frequencies in T/B. range. T/B. output approx. 10 v. peak to peak. Built-in 1V calibrator. Facility for "Z" axis modulation. Electronically stabilised power supply. Power req. 200-250 v. A.C., 40-60 c/s., 80 watts. Fused. Front panel silver and charcoal grey. Cabinet, charcoal grey, size 8⅝ x 14 x 17in. deep. Net weight 23lb. 56-page construction and operation manual.

Kit ..... £32.12.6 Assembled £41.10.0

TV ALIGNMENT GENERATOR Model HFW-1



Designed to offer the maximum in performance, flexibility and utility at the lowest possible cost. Frequency coverage 3.6 Mc/s. to 220 Mc/s. on fundamentals. Unique non-mechanical sweep oscillator system. High level output on all ranges. Sweep deviations up to 42 Mc/s. Built-in fixed and variable marker generators. (5 Mc/s. crystal supplied). Power requirements: 110/200-250 v. A.C., 50 watts. Size 13 x 8½ x 7in.

Kit ..... £34.18.0 Assembled £44.10.0

De Luxe 6in. VALVE VOLTMETER Model 1M-13U

Modern styling. Extra features. The ideal VVM for the Electronic Engineer. 6in. Ernest Turner 200μA. meter with multi-coloured scales. Unique gimbal bracket allows bench, shelf or wall mounting. Measures A.C. (r.m.s.), D.C. volts 0-1.5, 5, 15, 50, 500, 1,500. Resistance range 0.1 to 1,000MΩ with int. battery. Vernier-action zero and ohms adjustment. Roller-tinned printed circuit. High input resistance (11MΩ). Comprehensive assembly and operation manual. Size 5 x 12½ x 4½in. Complete with test prod and leads.

Kit .....£18.18.0 Assembled £26.18.0

H.V. and R.F. Probes available as optional extras.

OUTSTANDING EQUIPMENT FOR AUDIO ENTHUSIASTS

P.A. AMPLIFIER Model PA-1

A multi-purpose, high output, compact unit, suitable for vocal and instrumental groups, guitars, electronic organs etc. 4 inputs for guitars, microphones, record players. Has many features found only in expensive equipment, i.e. 50 watt Amplifier, two heavy duty speakers, "Magic Eye" volume indicator, variable tremolo, modern elegant cabinet.

Kit ..... £54.15.0 Assembled £74.0.0.

(Legs optional extra 17/6 set of 4).

STEREO AMPLIFIER Model S-99

9 watts per channel. Within its power rating this amplifier is the finest available, regardless of price. Features include: Inputs for stereo/mono; Gram, Radio and Tape; sensitivity to meet the requirements of any pick-up; push-button selection; variable filter for optimum performance; excellently styled in two-tone grey perspex panel with golden surround and matching knobs. Suitable for cabinet mounting or as a free-standing unit. Size 13½in. x 4½in. x 12½in. deep.

Kit ..... £27.19.6 Assembled £37.19.6

MODELS TO ENTERTAIN YOUR FAMILY AND FRIENDS

"OXFORD" LUXURY TRANSISTOR PORTABLE Model UXR-2

This superb transistor radio is the ideal domestic or personal portable Medium and Long Wave receiver. Solid leather case and handle. Easy-to-read tuning scale. Extra large loudspeaker. Push button L, MW and tone. 10 semi-conductors (7 transistors plus 3 diodes). Sockets for personal earphone, tape recorder, car aerial. Internal 9-volt battery (not supplied), lasts for months. Latest printed circuit techniques.
Comprehensive, easy-to-follow, fully illustrated Instruction Manual.

Kit ..... £14.18.0 incl. P. Tax

Assembly can be arranged on your behalf.

A WELL DESIGNED F.M. TUNER Model FM-4U

Tuning range 88-108 Mc/s. Flywheel tuning. Attractive Plastic Front Panel in two-tone grey with golden trim surround and motif. Thermometer type visual tuning indicator. Pre-aligned. I.F. transformers. Three I.F. stages, Wide-band low distortion Ratio Detector. R.F. Unit, wired, tested and pre-aligned. Printed circuit for I.F. Amplifiers and Ratio Detector. Built-in power supply. Output sockets for stereophonic adaptor (for stereo transmission when available).
TUNER UNIT Model FMT-4U with 10.7 Mc/s. I.F. output, £2/15/- (inc. P.T.). **I.F. AMPLIFIER and power supply Model FMA-4U** complete with case and valves, £13/3/-. Sold separately.

Kit Total £15.18.0

Assembly can be arranged on your behalf.

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So easy to use

NEW MODEL

DE-LUXE LABORATORY TRANSISTOR TESTER. MODEL IM-30U

Unmatched for Quality and Performance at the price

★ Provides complete d.c. analysis of PNP and NPN Transistors.
★ D.C. gain (Beta, Alpha) read direct on calibrated scales.
★ 15μA basic range for leakage tests.
★ Four lever switches for fast, easy, test selection.

★ Internal batteries for tests up to 9 v.
★ Provision for connection to separate power supply for higher voltage and current.
★ Large easy-to-read dial.
★ Comprehensive construction and operation manual.

The Heathkit De Luxe Laboratory Transistor Tester will be found invaluable for servicing, design work, inspection, production testing. Tests include base current gain, collector current, collector voltage, leak voltage, short test, diode or collector-to-emitter leakage (Iceo) and collector-to-base leakage (Icbo). In all an outstanding instrument, with attractive and modern functional styling.

Kit **£24.18.0** Assembled **£35.10.0**

6 W STEREO AMPLIFIER KIT Model S-33

A versatile high-quality self-contained STEREO/MONAURAL Amplifier with adequate output for a living room. Can be used to convert a favourite (monaural) radiogram into a stereo-radiogram. 3 watts per channel: 0.3% distortion at 2.5 w/channel; 20 dB N.F.B., inputs for Radio (or Tape) and Gram, Stereo or Monaural; Ganged controls. Sensitivity 200 mV.

Kit **£13.7.6** Assembled **£18.18.0**

6 W HI-FI STEREO AMPLIFIER KIT Model S-33H

An inexpensive stereo-mono amplifier with the high sensitivity necessary for lightweight miniature ceramic pick-ups (e.g., Decca Deram). De luxe version of the S-33 with attractive two-tone grey Perspex panel.

Kit **£15.17.6** Assembled **£21.7.6.**

5 W HI-FI MONO AMPLIFIER KIT Model MA-5

A low-priced general purpose Hi-Fidelity amplifier based on the popular S33 for those who do not require a stereophonic system. Separate bass and treble controls. Gram and Radio inputs. Suitable for most crystal pick-ups. A printed circuit simplifies construction.

Kit **£10.19.6** Assembled **£15.10.0**

HI-FI MONO POWER AMPLIFIER KIT Model MA-12

A compact high fidelity power amplifier (including auxiliary power supply). 12 watts output. Wide frequency range and low distortion. A variable sensitivity control is fitted enabling it to be used with an existing amplifier in a stereophonic system. Other applications include sound reinforcement systems, transmitter modulators, for use with tape recorders, also as a general purpose laboratory amplifier.

Kit **£11.18.0** Assembled **£15.18.0**

STEREO CONTROL UNIT KIT Model USC-1

Incorporates all worthwhile features for high fidelity stereo and mono. Push-button selection, accurately matched ganged controls to ±1 dB. Negative feedback rumble and variable low-pass filters. Printed circuit boards. Accepts inputs from most tape-heads and any stereo or mono pick-up.

Kit **£19.10.0** Assembled **£26.10.0**

AMERICAN HEATHKIT SINGLE SIDE BAND EQUIPMENT

For direct delivery from U.S. Plant. Send for details of models. Fully illustrated American Catalogue of Heathkit range sent for only 1/- post paid.

SEND FOR FREE BRITISH CATALOGUE

Full details of any model sent on request.

"MALVERN" HI-FI EQUIPMENT CABINET KIT

AN ATTRACTIVE CABINET in modern style designed to house all your 1[1]Hi-Fi equipment (including tape deck and full-sized transcription record player). The cabinet parts are veneered and pre-drilled, with edging in Panoplex plastic strip for ease of finishing. Complete with everything you need for assembly, including screws, hinges and even a padsaw! Left "in the white" for finishing to choice. Size 39½ x 32 x 21½in.

Kit **£18.1.0** (inc. P.T.) Assembled **£23.6.0**

"GLOUCESTER" HI-FI CABINET KIT

Will accommodate: Tape Deck and/or Record Player. F.M. Tuner and Stereo Amplifier. For those with limited floor space a speaker system can be housed at one end. For this purpose a loud-speaker kit comprising one 4in. plus 8in. speaker systems, balance unit, speaker grille, cutting template, padsaw and mounting details is also available. Neutral hardwoods have been carefully selected so that the finished product can be stained and polished to individual choice. There is storage space for records, etc., also for power amplifiers. Dimensions: length 46½in., height 30in., depth 21in.

Mk. I for Tape Deck or Record Player

Kit **£17.3.6** (inc. P.T.) Assembled **£22.8.6**

Mk. II for both T/D and R/P

Kit **£18.10.0** (inc. P.T.) Assembled **£23.15.0**

TELEPHONE AMPLIFIER KIT

Model TTA-1 for home, office or shop.

Kit **£7.9.6.** Assembled **£11.15.0**

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● **Deferred Terms available on orders above £10** ●

MONO CONTROL UNIT KIT Model UMC-1

Ideal for use with MA-12 or similar amplifier. Output 0.25 v. *Send for full details.*

Kit **£8.12.6** Assembled **£13.12.6**

HI-FI SPEAKER SYSTEM KIT Model SSU-1

Ducted-port bass reflex cabinet "in the white." Frequency response is 40-16,000 c/s. Power rating 10 watts. Matched speaker units 8in. high flux (12,000 lines) with hyperbolic cone and 4in. wide angle dispersion type for higher frequencies.

Kit (with legs) **£11.12.0** (Less legs) **£10.17.6** (inc. P.T.)

"COTSWOLD" SPEAKER SYSTEM KIT

This acoustically designed enclosure measures 26 x 23 x 14½in., and houses a special 12in. bass speaker with 2in. speech coil, elliptical middle speaker together with a pressure unit to cover the full frequency range of 30-20,000 c/s. Its polar distribution makes it ideal for really Hi-Fi Stereo. Delivered complete, with speakers, cross-over unit, level control, grille cloth, etc. Left "in the white" for finish to personal taste, all parts are pre-cut and drilled for ease of assembly.

Kit **£23.4.0** Assembled **£30.15.0**

"COTSWOLD M.F.S." SPEAKER SYSTEM KIT

This model, based on the standard Cotswold, measures only 36in. high, 16½in. wide by 14in. deep. Particularly recommended to those who require the best results in small rooms.

Kit **£23.4.0** Assembled **£30.15.0**

How to install hi-fi in YOUR home

If you are planning to install a Hi-Fi system in your home, and are uncertain of the type of equipment to use, our widely experienced technical staff will with pleasure put forward recommendations. All you have to do is state the type of installation contemplated, the price you are prepared to pay and give details of existing equipment you wish to include, if possible.

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MANUFACTURERS OF THE WORLD'S LARGEST-SELLING ELECTRONIC KIT-SETS

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MULTIMETER KIT Model MM-1U

Provides wide voltage, current, resistance and dB ranges to cover hundreds of applications. Sensitivity 20,000 ohms/volt D.C. and 5,000 ohms/volt A.C. Ranges: 0-1.5 v. to 1,500 v. A.C. and D.C.; 0-150μA. to 15 A. D.C. Measures resistance from 0.2Ω to 20MΩ. 4½in. 50μA meter. A polarity reversing switch eliminates transferring test leads when alternately measuring + and − voltages. Uses standard commercial batteries.

Kit £12.18.0 Assembled £18.11.6

OSCILLOSCOPE TRACE DOUBLER KIT Model S-3U

This device will extend the use of your single-beam oscilloscope and, at a nominal cost, will give you the advantages of a double (or other multiple) beam 'scope.

Kit £12.18.0 Assembled £18.10.0

R.F. SIGNAL GENERATOR KIT Model RF-1U

Provides extended frequency coverage on six bands from 100 kc/s, 100 Mc/s on fundamentals and up to 200 Mc/s on calibrated harmonics.

Kit £13.8.0 Assembled £19.18.0

DECADE RESISTANCE BOX KIT

Model DR-1U. Range 1-99,999Ω in 1Ω steps. Ceramic switches throughout. Current rating from 500 mA. to 5 mA. according to decades in circuit. Polished wooden cabinet supplied complete.

Kit £10.8.0 Assembled £14.8.0

RESISTANCE-CAPACITANCE BRIDGE KIT Model C-3U

Measures capacitance 10pF. to 1,000μF. Power factor and resistance 100Ω to 5M ohms. Test voltages 5-450 v. Safety switch provided.

Kit £10.10.0 Assembled £16

AUDIO SIGNAL GENERATOR KIT Model AG-9U

10 c/s. to 100 kc/s., switch selected. Distortion less than 0.1%. 10 v. sine wave output metered in volts and dB's.

Kit £22.10.0 Assembled £30.10.0

AUDIO VALVE MILLIVOLTMETER KIT Model AV-3U

A very sensitive meter with high stability. 1 mV. to 300 v. A.C. The frequency response is virtually flat up to 100 v. f.s.d. within ±1 dB from 10 c/s. to 400 kc/s. 4½in. 200μA. moving coil meter.

Kit £16.10.0 Assembled £22.18.0

AUDIO WATTMETER KIT Model AW-1U

This popular meter is used in many recording studios and broadcasting stations as a monitor as well as for servicing purposes. Dissipation rating up to 25 w. continuous, 50 w. intermittent.

Kit £17.5.0 Assembled £23.18.0

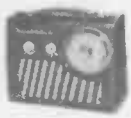
A.M./F.M. TUNER KIT

Tuning range 88-108 Mc/s. (FM) 16-50, 200-550, 900-2,000 m. Flywheel tuning. Attractive Perspex front panel in two-tone grey with golden trim. Thermometer type tuning indicator, pre-aligned I.F. transformers. Switched wide and narrow A.M. bandwidths.

TUNING HEART Model AFM-T1 £4/13/6 (inc. P.T.) I.F. AMPLIFIER and Power Unit Model AFM-A1. Complete with metal cabinet and valves £21/16/6. Sold separately.

Kit Total £26.10.0

DUAL-WAVE TRANSISTOR PORTABLE RADIO KIT Model UXR-1



Presented in elegant real hide case with tasteful gold relief. Can be assembled in 4 to 6 hours and you have a set in the top flight of transistor portables. Pre-aligned I.F. transformers, printed circuit and a 7in. x 4in. high flux speaker.

Covers both Long and Medium waves. Dimensions 9½in. x 7½in. x 3½in.

Kit £12.11.0 (inc. P.T.)

4-wave TRANSISTORISED PORTABLE RADIO KIT Model RSW-1

Using 7 latest type transistors and three diodes this highly sensitive set is specially designed for Short and Medium wavebands (200-550, 90-200, 20-40 and 11-16 m.). An internal ferrite aerial is provided for medium wave and a car aerial socket is also fitted. Housed in an elegant leather case with retractable whip aerial this set will receive broadcasts from all over the world.

Kit £19.17.6 (inc. P.T.).

JUNIOR TRANSISTOR RADIO KIT Model UJR-1

A dual-wave headphone receiver for use with external aerial and earth. Specially designed as a practical introduction to radio and electronics and is particularly suitable for absolute beginners. Kit £2.7.6 (inc. P.T.).

Additional Amplifier Stage UJR-1S, 16/6.

ELECTRONIC WORKSHOP KIT Model EW-1

20 exciting experiments can be made with this one kit. Transistor Radios, Intercom. Sets, Burglar Alarm etc. A 72 page illustrated manual is included. Ideal for the junior experimenter. Kit £7.13.6 (inc. P.T.).

TAPE DECKS are available as "packaged deals" with other equipment. Details on request.

HEATHKIT THOMAS (Transistorised) ELECTRONIC ORGAN KIT. Model GD-232BE. Can be built with no knowledge of electronics. *Send for details.*

Money-back Guarantee

Daystrom Limited unconditionally guarantee that each Heathkit model assembled in accordance with our easy-to-understand instruction manual must meet our published specifications for performance or the purchase price will be cheerfully refunded.

● Deferred Terms available on all orders above £10.

4½in. VALVE VOLTMETER KIT Model V-7A

The world's most popular valve voltmeter, with printed circuit and 1 per cent. precision resistors to ensure consistent laboratory performance. It has 7 voltage ranges measuring respectively D.C. volts to 1,500 and A.C. to 1,500 r.m.s. and 4,000 peak to peak. Resistance measurements from 0.1 ohm to 1,000 megohms with internal battery. D.C. input resistance is 11 megohms and dB measurement has a centre-zero scale. Complete with test prod, leads and standardising battery. Power requirements, 200-250 v. 40-60 c/s. A.C., 10 watts.

Kit £13.18.6 Assembled £19.18.6

HIGH VOLTAGE PROBE KIT Model HV-336

Extends measurement up to 30,000 v. D.C. with negligible circuit loading. A special High Stability 1,090 megohm resistor gives a multiplication factor of 100X when used with a valve voltmeter of 11 megohms input resistance such as the V-7A.

Kit £2.19.6

R.F. PROBE KIT Model 309-CU

This complete probe kit will extend the frequency range of the V-7A Valve Voltmeter to 100 Mc/s. and will enable useful voltage indication to be obtained up to 300 Mc/s.

Kit £1.13.6 Assembled £2.2.0

POWER SUPPLY UNIT KIT Model MGP-1

Compact, general purpose unit suitable for F.M. Tuners, Tape Recording Amplifiers and general laboratory use. Input 100/120 v., 200/250 v., 40-60 c/s. Output 6.3 v., 2.5 A. A.C.; 200, 250, 270 v., 120 mA. max. D.C.

Kit £5.2.6 Assembled £6.12.6

DECADE CAPACITOR KIT Model DC-1

Capacity values 100μμF to 0.111μF. in 100μμF. steps. Precision silver-mica capacitors and minimum loss ceramic wafer switches ensure high accuracy.

Kit £7.5.0 Assembled £10.8.0

2¾in. SERVICE OSCILLOSCOPE KIT Model OS-1

Light, compact, portable for service engineers. Printed circuit board for easy construction. Time base 15 c/s. to 150kc/s. in four ranges and 50 c/s. sine wave sweep. Flyback suppression on all ranges. Internal, external and 50 c/s sync. Size 5 x 8 x 14½in. long. Weight 10½lb.

Kit £22.18.0 Assembled £30.8.0

CAPACITANCE METER KIT Model CM-1U

This Direct-Reading Capacitance Meter is a very low priced, time-saving instrument which is so useful that it should be part of the general equipment of every electronic laboratory and production line. Easily built in a few hours. 0-100μμF., 0-1,000μμF., 0-0.01μF., 0-0.1μF. The meter has 4½in. scale and can be used by an unskilled operator after a few minutes' instruction.

Kit £15.15.0 Assembled £21.14.0

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AMATEUR TRANSMITTER KIT
Model DX-40U

Covers all amateur bands from 80 to 10 metres, crystal controlled. Power input 75 watts C.W. 60 watts peak controlled carrier phone. Output 40 watts to aerial. Provision for VFO. Filters minimise T.V. interference. Modulator and power supplies are built-in. Single knob band switching is combined with a pi-network output circuit for complete operating convenience. A high-grade moving-coil meter indicates the final grid or anode current. Provision is made for the use of 3 crystals with access through a trap-door in the back of the cabinet. A 4-position switch selects the appropriate crystal or a jack for external VFO which can be used instead of the crystal(s).

Kit ... £33.19.0 Assembled ... £45.8.0

SINGLE SIDEBAND ADAPTER KIT
Model SB-10U

May be used with most A.M. transmitters with certain provisions. Allows full use of existing equipment for SSB facilities. Band coverage: 80, 40, 20, 15, 10 m. Unwanted sideband suppression; better than 30 dB. Carrier suppression: better than 40 dB. Power requirements: 300 v. D.C. 85 mA. (average) 30 mA. (standby), 140 mA (transmit). 6.3 v. A.C., 3.5 A. Meter: 2½in. Scale edge reading, 200μA movement, indicates carrier null and relative power output. Cabinet 11in. high x 8in. wide x 14¾in. deep.

Kit ... £39.5.0 Assembled ... £54.18.0

AUDIO SINE-SQUARE WAVE GENERATOR KIT. Model AO-1U

Covers 20 c/s. to 150 kc/s. in four ranges with choice of sine or square waves. The latter up to 10 kc/s. Output 10 v. max. and distortion less than 1%. Ideal for audio testing. Size 9½ x 6½ x 5in.

Kit ... £14.15.0 Assembled ... £21.5.0

GRID-DIP METER KIT. Model GD-1U

Functions as oscillator or absorption wavemeter. With plug-in coils for continuous frequency coverage from 1.8Mc/s. to 230 Mc/s.

Kit...£10.19.6 Assembled...£13.19.6

Additional Plug-in Coils Model 341-U extend coverage down to 350 kc/s. With dial correlation curves, 17/6.

TRANSISTOR INTERCOM KITS
Models XI-1U and XIR-1U

Ideal for home or business use. Up to five remote stations can be operated with each Master. The Master unit can call any one, any combination, or all five Remote stations and any Remote station can call the Master. A private call to any Remote station cannot be interrupted or overheard by any other while a conversation is in progress. Any Remote station can talk to any one or all others provided the Master is manned. These kits have been designed for easy construction and high performance. The mahogany veneered wooden cabinets are supplied completely assembled and finished. The Master unit has a 4-transistor amplifier and is operated by an internal 9 v. battery as are the Remote units. Batteries are not included with the Kits.

Model XI-1U (Master)

Kit ... £10.19.6 Assembled ... £16.19.6

Model XIR-1U (Remote)

Kit ... £4.7.6. Assembled ... £5.16.0

A WIDE RANGE OF BOOKS ON ELECTRONICS AND RADIO AVAILABLE.
Send for Lists and Prices.

"MOHICAN" GENERAL COVERAGE RECEIVER KIT
Model GC-1U

This fully transistorised receiver which includes 4 piezo-electric transfilters, is in the forefront of receiver design. It is an excellent portable or fixed station receiver. The R.F. "front-end" is supplied as a pre-assembled and pre-aligned unit. Its many features include a 10-transistor circuit, printed circuit board, telescopic whip antenna, tuning meter, and a large slide-rule dial giving a total length of approximately 70 inches. Housed in a steel cabinet and powered by two 6 volt dry batteries (not supplied), mounted internally, it gives frequency coverage from 580 kc/s. to 30 Mc/s. in five bands; thus enabling world-wide reception. Electrical bandspread covers the amateur bands from 80 to 10 metres—each band having a scale length of approximately 8 inches. BFO tuning and Zener diode stabiliser. Size 6½ x 12in. x 10in.

Please write for specification leaflet.

Kit ... £37.17.6 Asmbld. ... £45.17.6

STABILISED POWER PACK
Models MSP-1M and MSP-1W

Specially recommended for industrial and laboratory use, meeting the need for a reliable and verstile stabilised power pack capable of a very high performance. Input 200-250 v. 40-60 c/s., A.C., fully fused. Outputs: H.T. 200-410 v. D.C. at 0-225 mA. in 3 switched ranges. Unstabilised A.C., 6.3 v. at 4.5 A. centre-tapped. Two 3in. "easy-to-read" meters for reading voltage and current simultaneously. Separate L.T. and H.T. supply transformers. All output circuits are isolated. Size 13in. x 8½in. x 9½in.

MSP-1M (with meters)

Kit ... £36.12.6 Asmbld. ... £43.12.6

MSP-1W (less meter)

Kit ... £29.17.6 Asmbld. ... £36.17.6

BALUN COIL UNIT KIT

Model B-1U. Will match unbalanced co-axial lines to balanced lines of either 75 or 300Ω impedance. Frequency range 10-80 m., input up to 200 watts.

Kit ... £4.15.6 Asmbld. ... £5.8.6

TAPE AMPLIFIER KITS
Models TA-1M and TA-1S

This Combined Tape Record/Replay Amplifier is available in both monophonic and stereophonic models. Model TA-1M can be modified to the stereo version with modification kit TA-1C.

TA-1M Kit £19.8.0. Asmbld. £28.18.0

TA-1S Kit £25.10.0 Asmbld. £35.18.0

TA-1C Kit ... £6.15.0

All prices include free delivery in the U.K.

Deferred Terms
are available on all orders above £10

AMATEUR TRANSMITTER KIT
Model DX-100U
The World's most popular Amateur TX Kit

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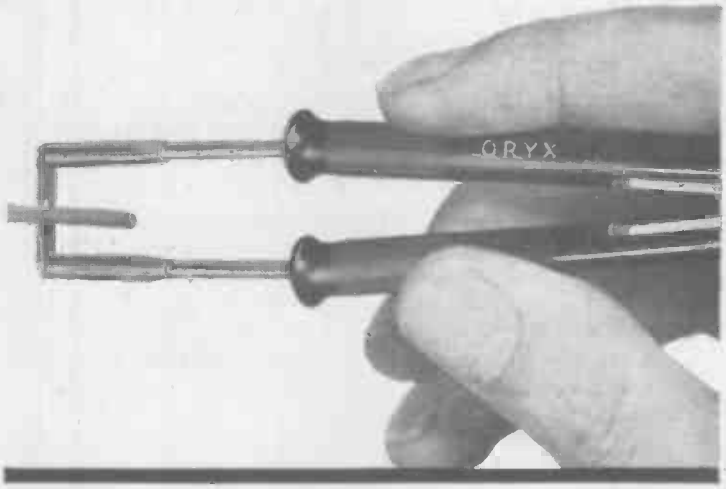

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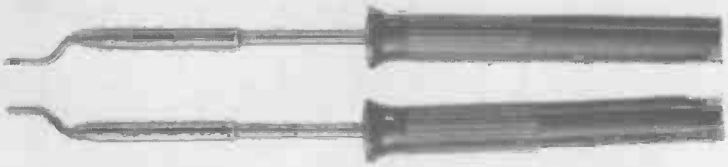

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G41 A

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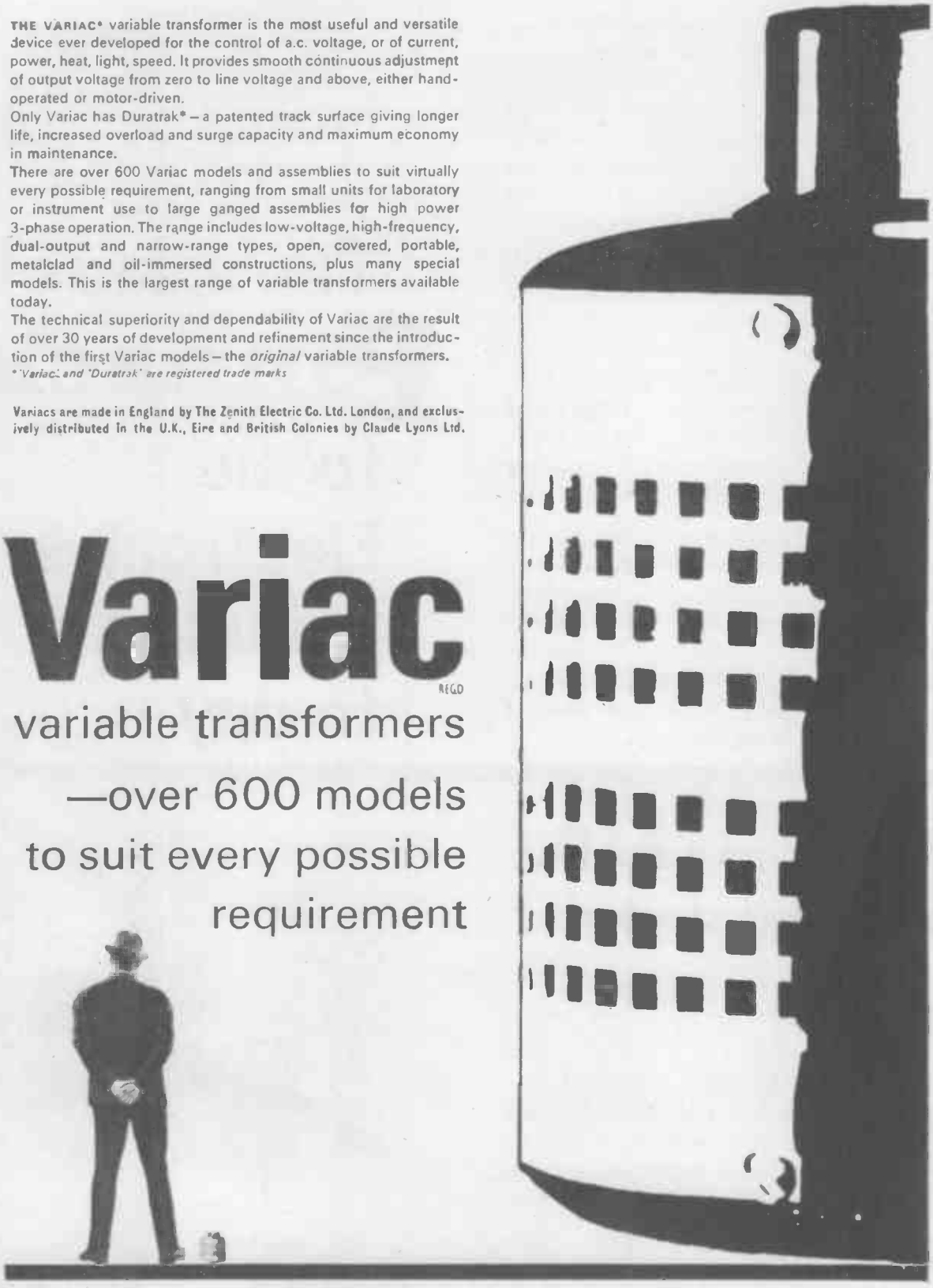

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Wireless World

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INTERNATIONAL SIZE LETTER	EEV TYPE NO.	AMERICAN† EQUIVALENT	APPLICATION
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B	BK42 (AR14T)	5551A	
	BK442 *	7669	
C	BK24 (AR10T)	5552A	Three phase welding
	BK168	5822A	
	BK444*	7671	
D	BK146	5553B	
C	BK44	5554	Power rectification and control
D	BK46	5555	
A	BK416	7703	Capacitor discharge
	BK428	—	
D	BK178	—	
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* Co-axial construction.

Full information on the complete range of Ignitrons available from EEV may be obtained from the address at the foot of the page. Enquiries from Government departments and overseas customers should be directed to the Sales Department, Chelmsford, Essex, England, Telephone: Chelmsford 3491 (Ext. 262) Telex: 99103, Telegrams: Enelectico, Chelmsford.

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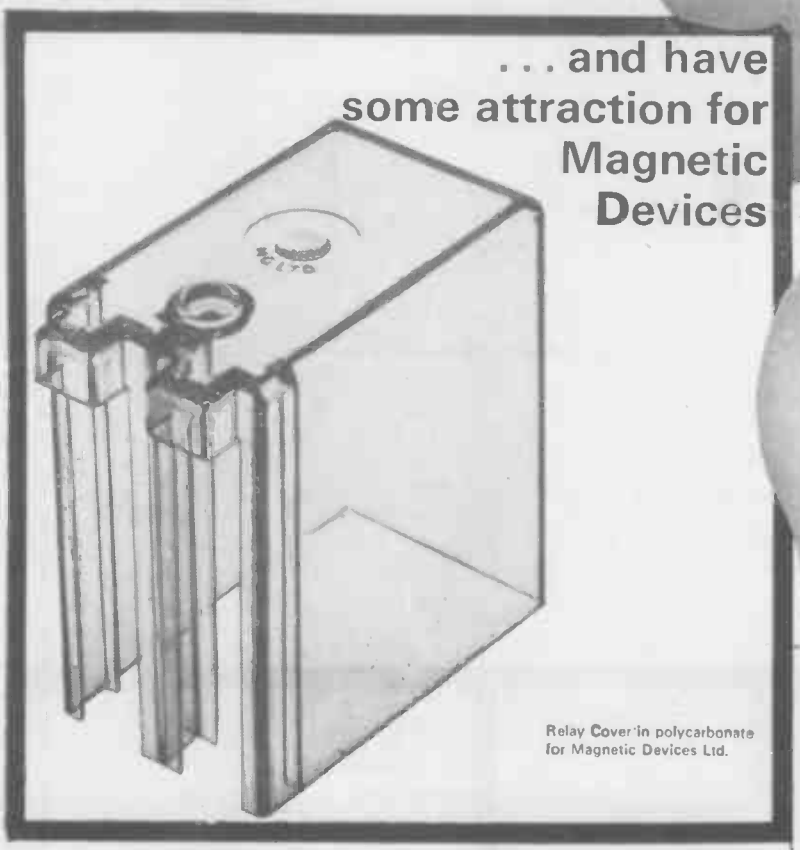

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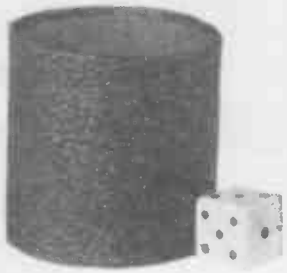
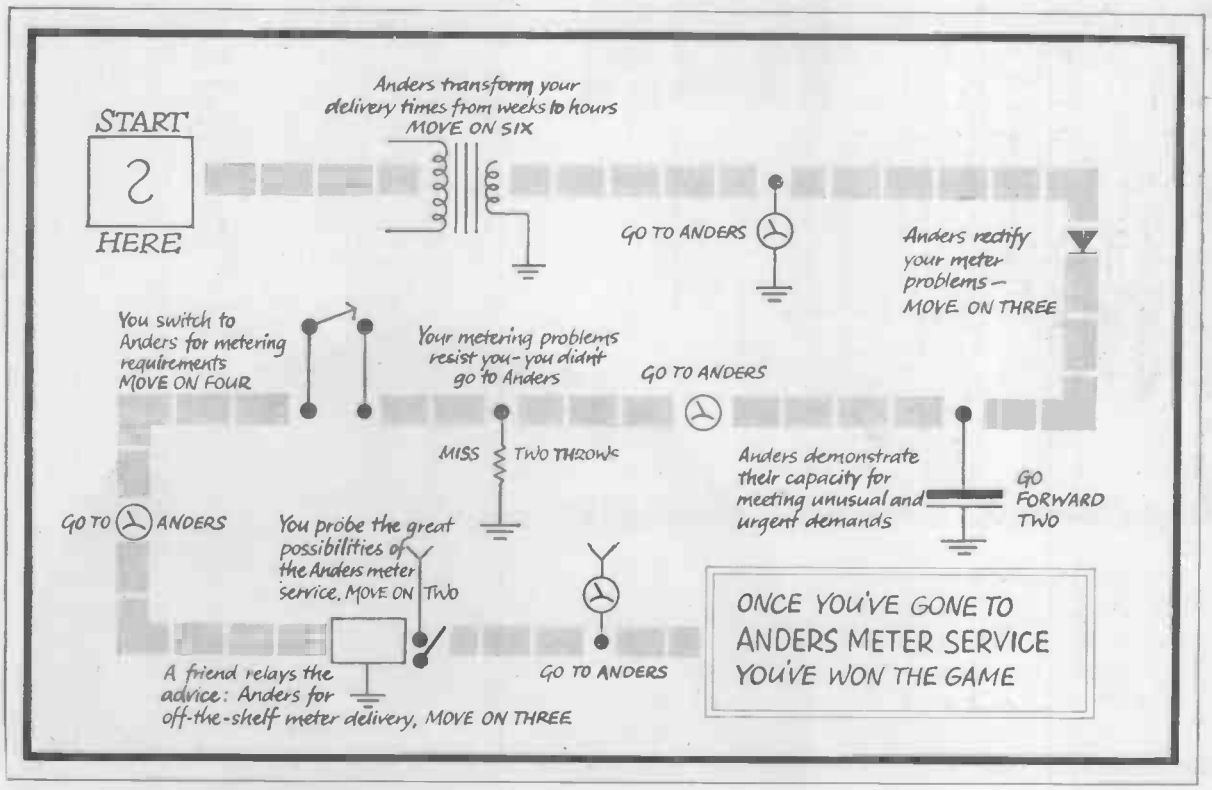


The meter game


START
HERE
Anders transform your delivery times from weeks to hours MOVE ON SIX
GO TO ANDERS
Anders rectify your meter problems — MOVE ON THREE
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GO TO ANDERS
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A friend relays the advice: Anders for off-the-shelf meter delivery, MOVE ON THREE
GO TO ANDERS
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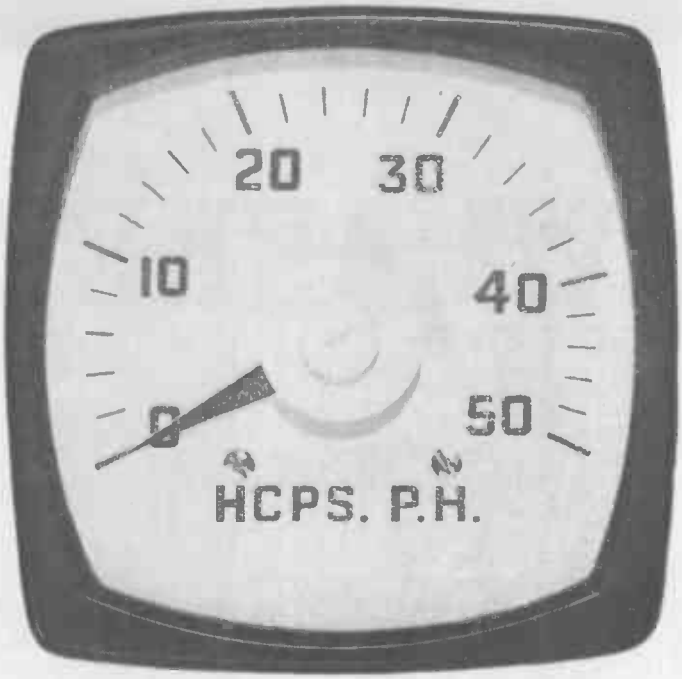

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THERE IS A SHURE SOLUTION TO ALL SOUND PROBLEMS

PROBLEM:

FEEDBACK

SOLUTION:

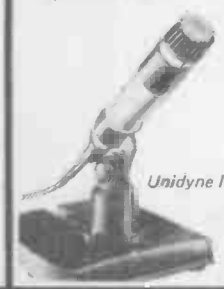
Model 55S Unidyne

Unidirectional Dynamic Microphone
This superb ultra-cardioid unidirectional microphone picks up every subtle shade of sound without distortion and with virtual suppression of random background noise. Thoroughly dependable, the Unidyne 55S will give long trouble-free service indoors or out. With its high output it can be used with low-gain systems as well as the highest quality sound installations. The Unidyne 55S is the most widely used high quality P.A. system microphone in the world. Multi-impedance switch (high-medium-low). Frequency response 50 to 15,000 c/s. With or without on-off switch.

PROBLEM:

BOOM

SOLUTION:



Unidyne III

Ultra-compact Unidirectional Microphone
The perfect solution to halls or rooms with annoying bass resonances. This popular unidirectional microphone prevents over-emphasis of bass tones and ensures natural lifelike voice reproduction. The Unidyne III is handsomely designed, versatile and sturdily built to withstand hard usage. As one of the smallest cardioid dynamic microphones in the world, it features an ultra-cardioid pick-up pattern symmetrical about the axis, uniform with frequency. Dual impedance, 50-15,000 c/s response. With or without on-off switch.

PROBLEM:

NOISE

SOLUTION:

Model 488

Noise-cancelling Controlled-magnetic Microphone
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PROBLEM:

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this storage space
no longer required

this storage space
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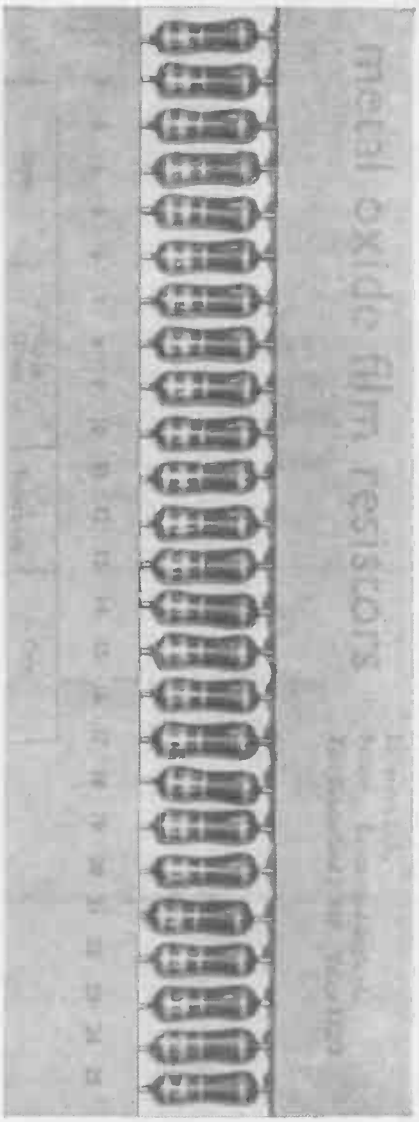

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ES/A57

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LONDON OLYMPIA 16-26 JUNE

interplas
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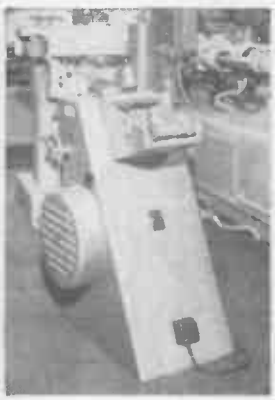
Many of the most brilliant achievements in plastics design in the International Design Display.

Information on all aspects of plastics and plastics trade—materials, markets, suppliers, customers, new applications.



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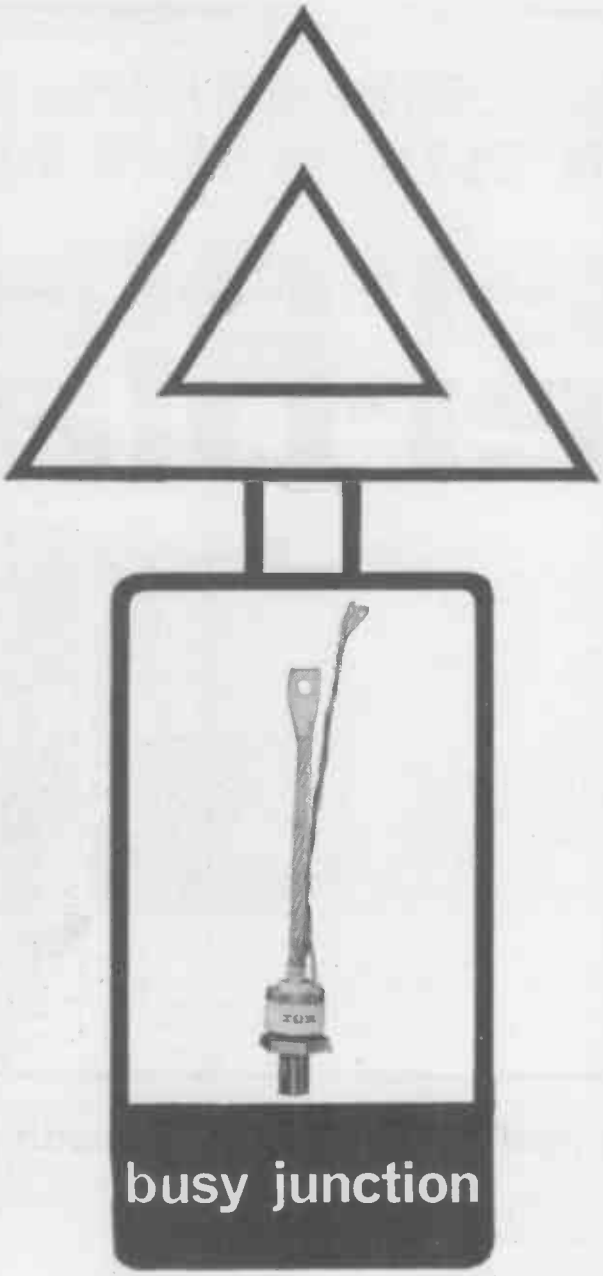

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LEICESTER 68561 · (LONDON S.E.27.) GYPSY HILL 6166 · (MIDDLESEX) SKYPORT 1314 · PORTSMOUTH 20465

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TRANSISTOR
R.C. OSCILLATORS
TYPES TG150, TG150M
TG150D & TG150DM

Continuous Frequency Coverage from 1·5 c/s to 150 kc/s in 5 Ranges at Decade Intervals

SPECIFICATION:

FREQUENCY
1.5 c/s to 150 kc/s
±3% + 0.15 c/s.

STABILITY
<0.05% drift after 30 seconds.
<0.3% drift for 30% fall of supply voltage.
<0.05% drift per °C at 1 kc/s.

DISTORTION
<0.1% at 1 kc/s;
<0.3% from 50 c/s to 15 kc/s;
<1.5% below 50 c/s and above 15 kc/s.

SINE WAVE OUTPUT
Variable up to 2.5V into 600Ω
<1% variation with frequency.
<0.5% change for 30% fall of supply voltage.

SQUARE WAVE OUTPUT
Variable up to 2.5V.
Rise time 1% of period + 0.2μs

ATTENUATOR
20dB, 40dB and 60dB; 600Ω.

SUPPLY
Self-contained PP9 batteries, life 400 hours, or, 200/250V A.C. when Power Supply Unit is fitted.

SIZE
10in. high x 6in. wide x 4¼in. deep.

WEIGHT
6 pounds.

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Grand Hall Gallery
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18th — 21st MAY

TYPE	TG150	TG150M	TG150D	TG150DM
Output Waveforms:	Sine only	Sine only	Sine and Square	Sine and Square
Output Meter:	None	0-2.5V and dB	None	0-2.5V and dB
Price with batteries:	£32	£42	£35	£45

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PORTABLE INSTRUMENTS

Mains Power Supply Unit £7.10.0

Leather carrying case £3.10.0

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Ferrograph

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Series "Y" instruments are housed in strong metal cases and, in some instances, can be rack-mounted. They are intended for those engaged in scientific research and industrial pursuits.

YD5 SINGLE CHANNEL RECORDERS

Model	Tape Speeds	Voltage	Frequency
YD5A	$7\frac{1}{2}$, $3\frac{3}{4}$ and $1\frac{7}{8}$ i.p.s.	100/250V	50 c.p.s.*
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*60 c.p.s. to order

Y500 DOUBLE CHANNEL RECORDERS

Model	Tape Speeds	Voltage	Frequency
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Y532A	$7\frac{1}{2}$, $3\frac{3}{4}$ and $1\frac{7}{8}$ i.p.s.	117V	60 c.p.s.
Y532E	$7\frac{1}{2}$, $3\frac{3}{4}$ and $1\frac{7}{8}$ i.p.s.	110V	50 c.p.s.
Y522UH	15 and $7\frac{1}{2}$ i.p.s.	200/250V	50 c.p.s.
Y522HA	15 and $7\frac{1}{2}$ i.p.s.	117V	60 c.p.s.
Y522HE	15 and $7\frac{1}{2}$ i.p.s.	110V	50 c.p.s.

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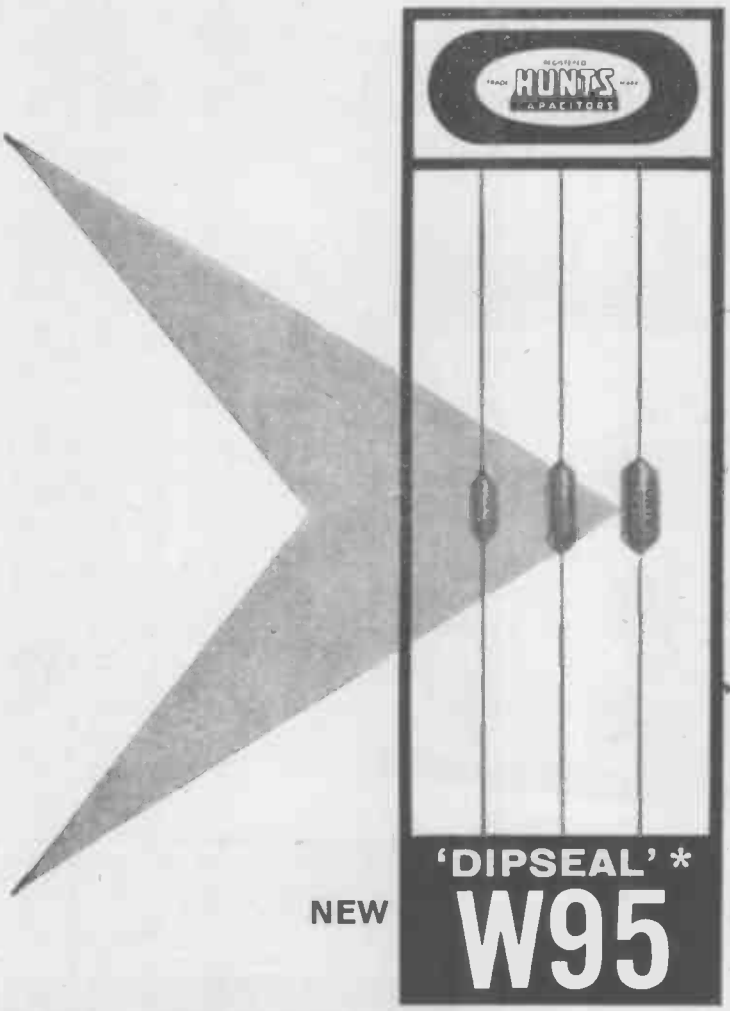

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Hunts new 'Dipseal' process gives designers and service engineers a *new kind* of capacitor—a proven, reliable metallised paper unit in a tough, resinous housing. New 'Dipseal' W95 midget tubulars are as small as or smaller than their thermoplastic cased equivalents; the humidity performance is better; and the hard *thermosetting* resinous housing is unaffected by heat, making soldering safe and easy.
Find out more about the new W95 and other 'Dipseal' ranges. Full particulars will be sent freely on request.

* Better humidity performance than thermoplastic cased units.
* Far cheaper than metal cased units.

TYPE W95 STANDARD RANGE

D.C. Working Voltage	Capacitance (μF)	Dimensions
250	0.004 to 0.05	12 to 15.5mm x 5.5 to 6.5mm
500	0.002 to 0.01	
750	50pf to 0.004μF	
Temperature Range: −55°C to + 100°C		Capacitance Tolerance ±20%

HUNTS

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Factories also in Surrey, and North Wales

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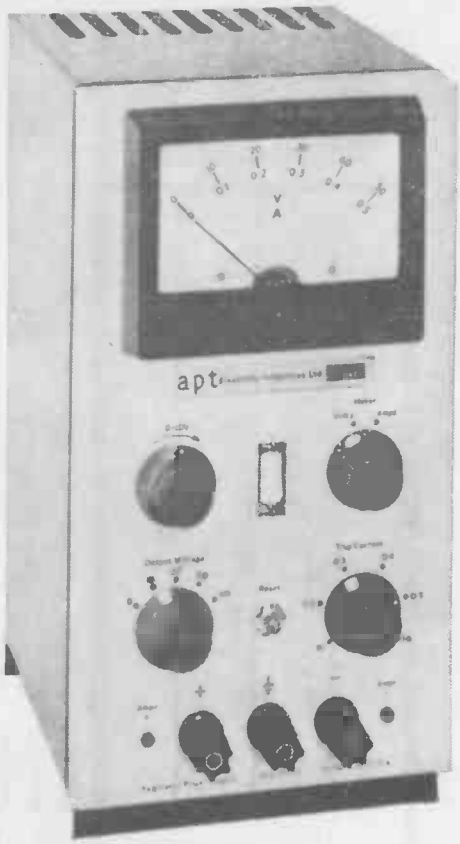

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Please send me your full catalogue of stabilised power supplies. ☐

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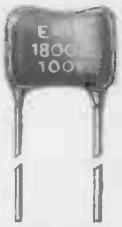
EDM15


EDM20

EDM30

Illustrations actual size

Erie Dipped Mica PLATE CAPACITORS

ERIE STYLE	EDM15	EDM20	EDM30
Volts Wkg d.c.	Capacitance—pF		
300	10-820	20-12000	510-30000
500	10-470	20- 8200	510-16000

The dip-coated silver-mica construction of the Erie EDM Series Capacitors provides outstanding stability, reliability and close tolerance characteristics coupled with versatility.

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−55°C to +125°C

Capacitance tolerances:
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Q factor:
1000 minimum*

Temperature Coefficient:
Generally −0 to +70 ppm/°C†

**except for very low values*
†except for low values

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An auxiliary square wave is also available at the repetition rate.

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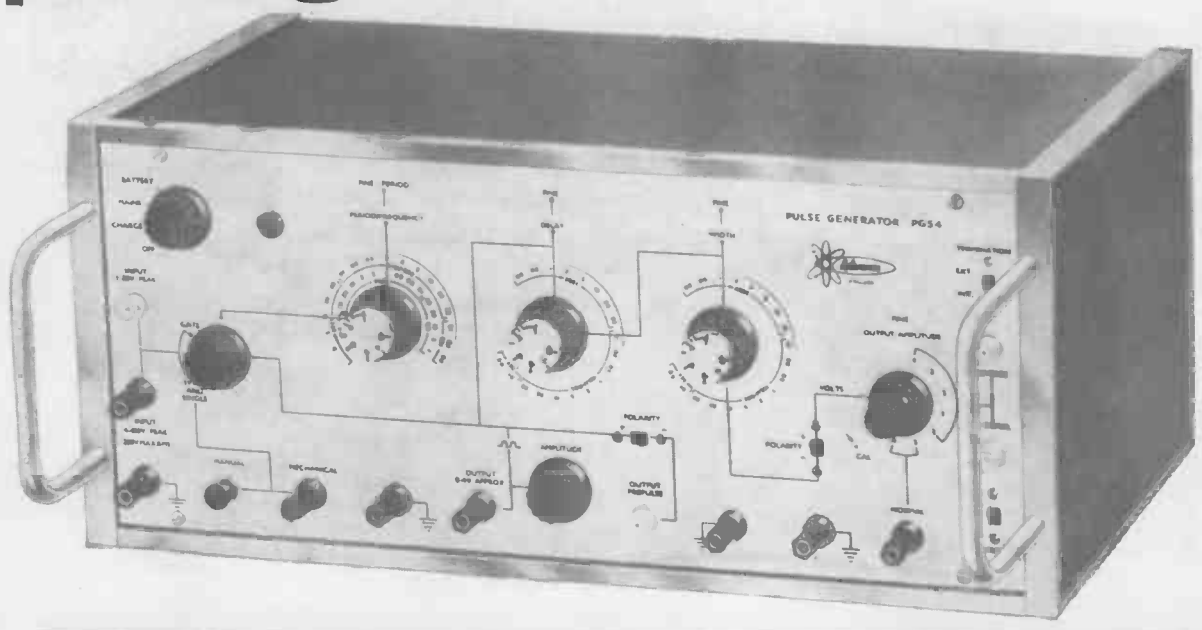
- Rise time less than 10ns up to 2V
- AC or Battery operation

NETT PRICE EX WORKS IN UK: £190 (excluding battery)

transistorised pulse generator PG54



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Electronic Instruments
Stabilised Power Supplies
Constant Voltage Transformers

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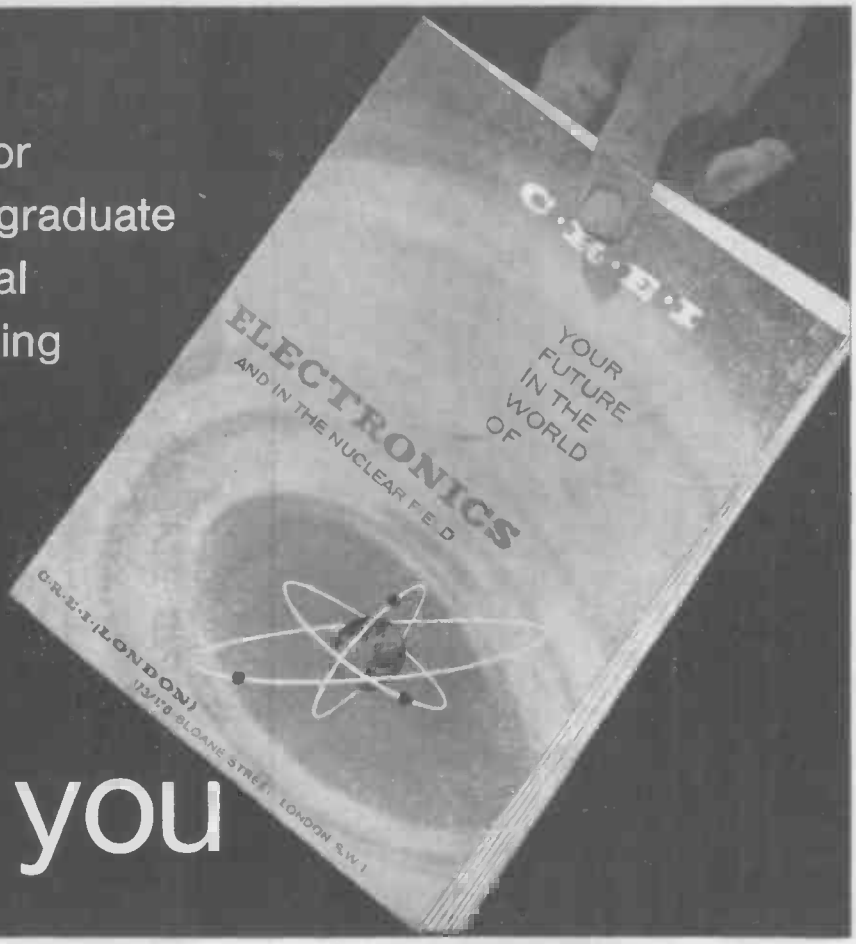

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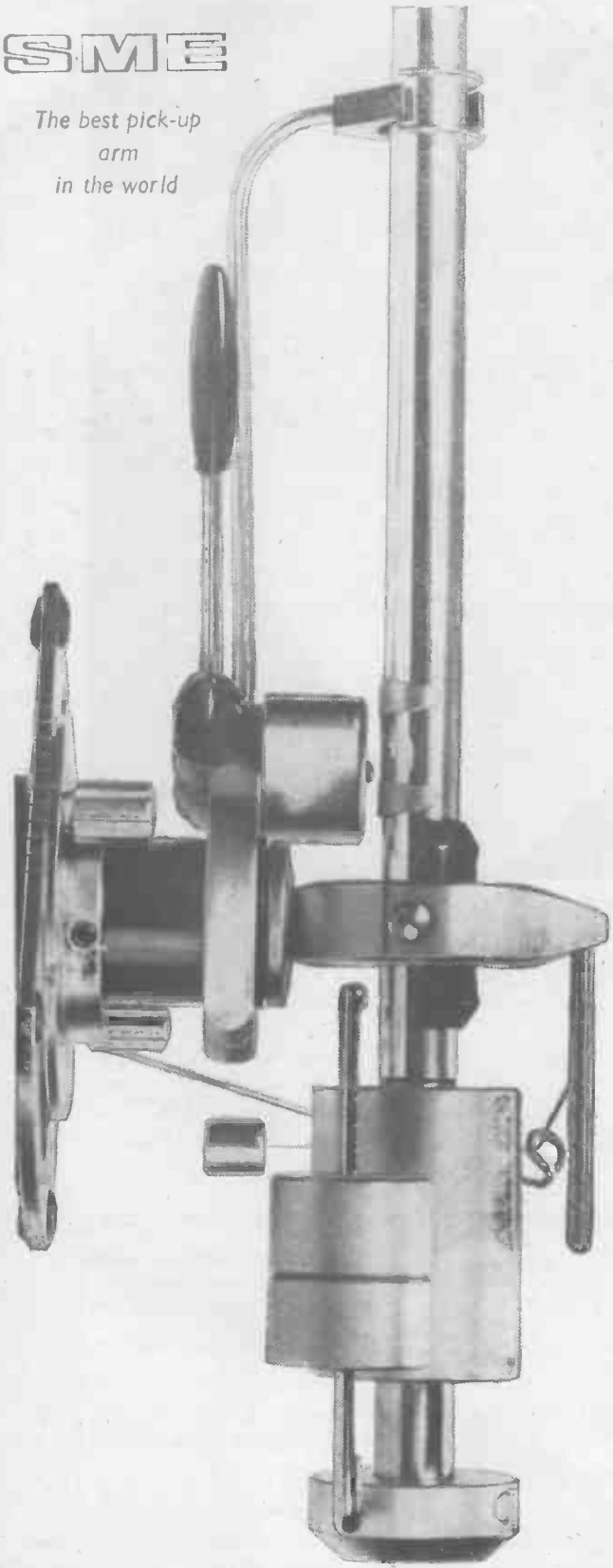

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or order straight away, working out total area of material required and referring to table below, which is for four-sided chassis in 16 s.w.g. aluminium.

48 sq. in.	4/3	176 sq. in.	9/–	304 sq. in.	13/6
80 sq. in.	5/6	208 sq. in.	10/–	336 sq. in.	14/9
112 sq. in.	6/6	240 sq. in.	11/3	368 sq. in.	15/9
144 sq. in.	7/9	272 sq. in.	12/6	and pro rata.	
P. & P. 2/6		P. & P. 2/9		P. & P. 3/-.	

Discounts for quantities. More than 20 sizes kept in stock for callers.

FLANGES (¼in., ⅜in.), 6d. per bend.

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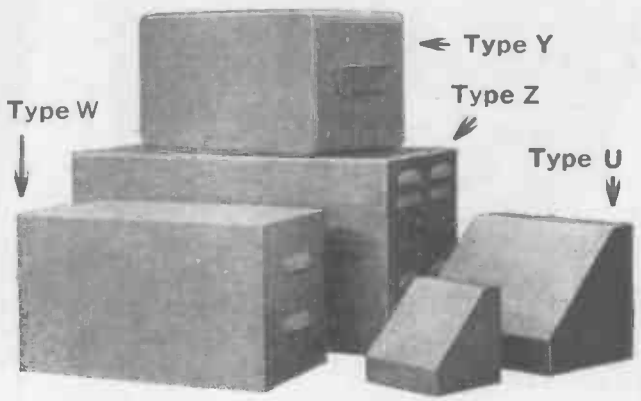
PANELS: Any size up to 3ft. at 5/3 sq. ft. 16 s.w.g.; (18 s.w.g. 4/6). Plus post and packing (over £2 free).



CASES

ALUMINIUM SILVER HAMMERED FINISH

Type	Size	Price	Type	Size	Price
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U	5½ x 4½ x 4½	15/6	Y	12 x 7 x 7	41/–
U	8 x 6 x 6	21/–	Y	13 x 7 x 9	46/–
U	15 x 9 x 9	44/6	Y	15 x 9 x 7	48/6
W	8 x 6 x 6	21/–	Z	17 x 10 x 9	66/–
W	12 x 7 x 7	34/–	Z	19 x 10 x 8½	71/–
W	15 x 9 x 8	44/–	*Height.		

Plus post and packing (over £2 free).

Type U has removable bottom or back. Type W removable front, Type Y all-screwed construction, Type Z removable back and front.

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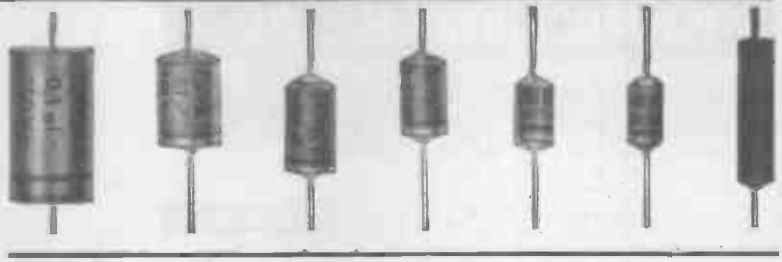

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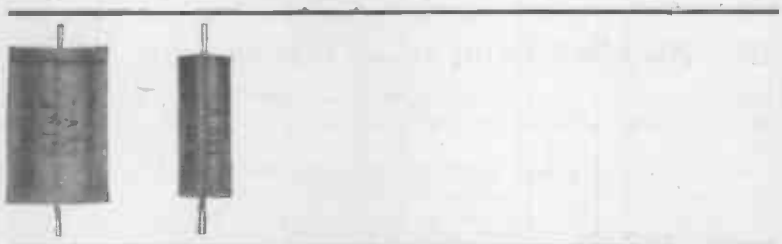
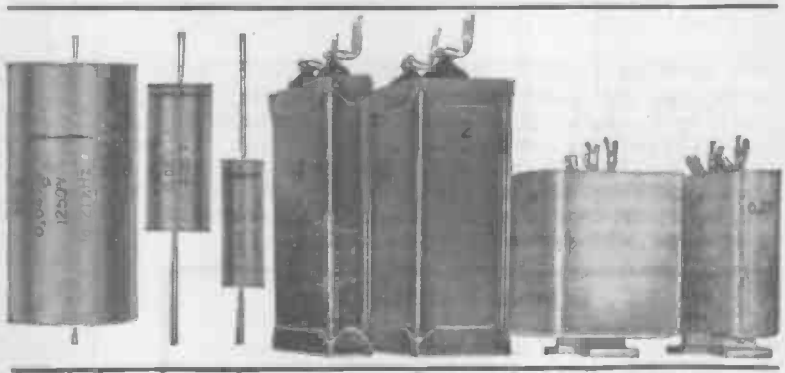
Range of Values	from 33pF to 0.47 μF
Tolerance	from 5% to 10%
Voltage Range	from 100V to 1000V



EROMAK I (Type Hf) Polycarbonate Capacitors

Range of Values	100pF to 1.0 μF
Tolerance	from 1% to 20%
Voltage Range	from 63V to 400V



Paper Capacitors

Tubular & Rectangular Can Styles

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Tolerance	10% & 20%
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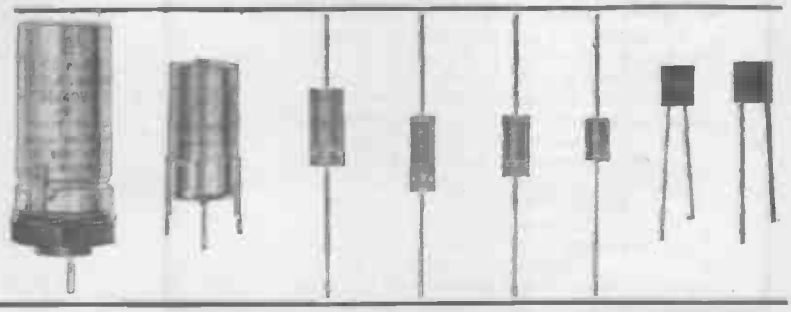
Multiple types also available



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Subminiature, miniature & standard types

Range of Values	from 0.1μF to 25000 μF
Voltage Range	from 3V to 450V

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M & P SPE9

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It is the biggest, widest-interest show of its kind. Three hundred exhibitors demonstrate the scientific and engineering progress which has rocketed our component exports 13 per cent this year.

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. . . components, accessories, valves, cathode-ray tubes, semi-conductors, instruments, test gear, materials, machinery and tools for . . .

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Nucleonic & atomic power control apparatus
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Tape recorders, record reproducers, film equipment
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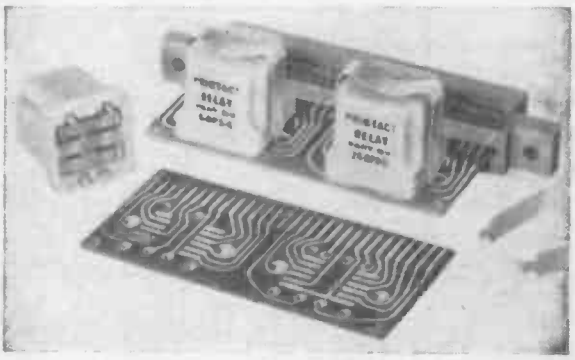
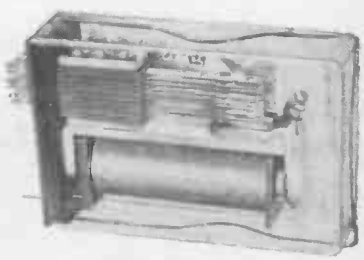
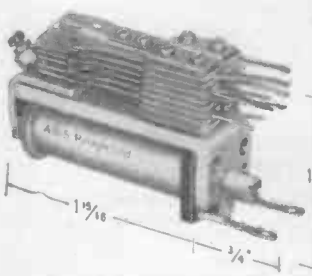


Supplied as standard or latching type, single or double winding. Size $\frac{7}{8}$in. cube, weight 0.8 oz.
Contact Rating 24 v. D.C. 3 pole double throw.
Voltage: 6, 12, 24, v. D.C. Power: 500 mW. Speed 10mS.
Temperature: 70° C max.

3000 TYPE PLUG-IN

Size 4in. x $2\frac{7}{8}$in. x $1\frac{1}{2}$in. Specification as 3000 type 6 change overs maximum, light duty.





S 1500 MINIATURES

A.C. or D.C. operating. Coil up to 10,000 ohms. Single or double winding. Contact material — Silver, Platinum, Spring Set — 6 change overs. Light duty maximum. Size: 2 11/16in. x $1\frac{1}{2}$in. x $\frac{31}{64}$in.

We are manufacturers of full ranges of 3,000 type, 600 type, and plug in relays, also 12 way mounting rack 19in. x $3\frac{1}{4}$in. Further details available on request to Mr. Clemens.

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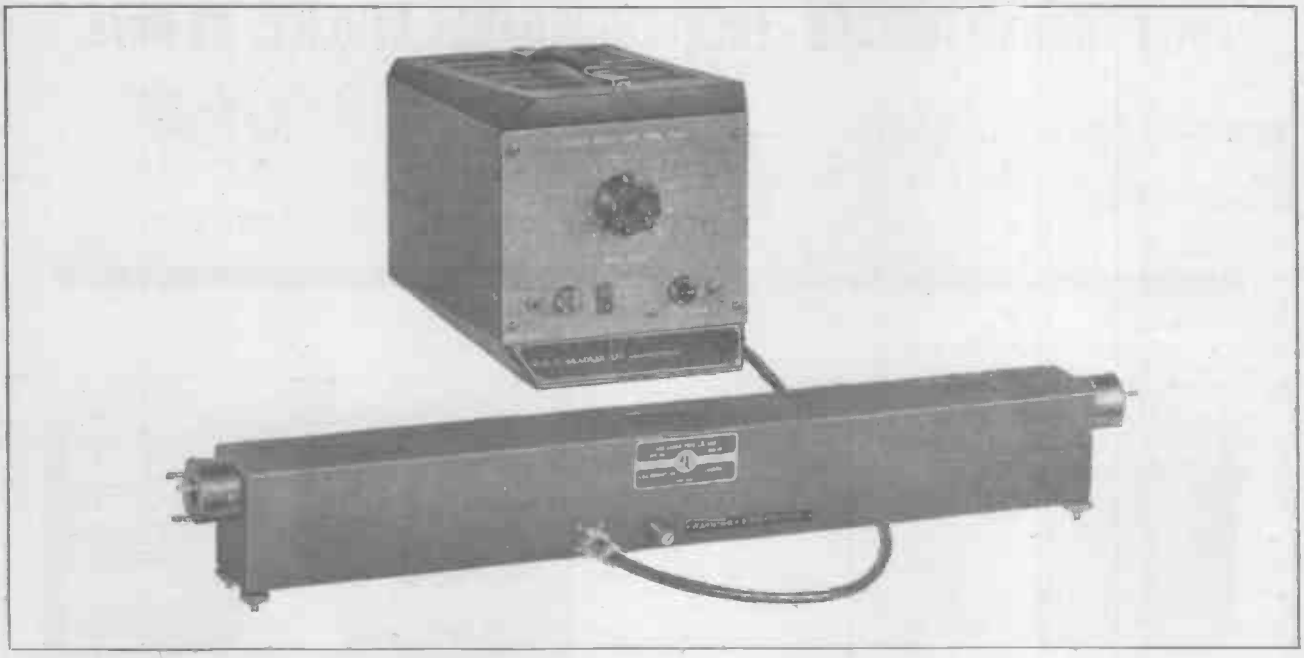
THE NEW GAS TYPE 602 LASER

Continuous Monochromatic Light Source



Bradley helium-neon Gas LASERS have a continuous high flux output of extreme spectral purity, readily appreciated by research groups, for applications such as Interferometry (Metrology and fine Measurement). Gas LASERS are rapidly replacing conventional light sources in schools and technical colleges, where their spectral purity and high flux greatly simplify the demonstration and explanation of optical principles and phenomena. The Bradley Gas Laser, Type 602, is the lowest-priced Laser in Europe.

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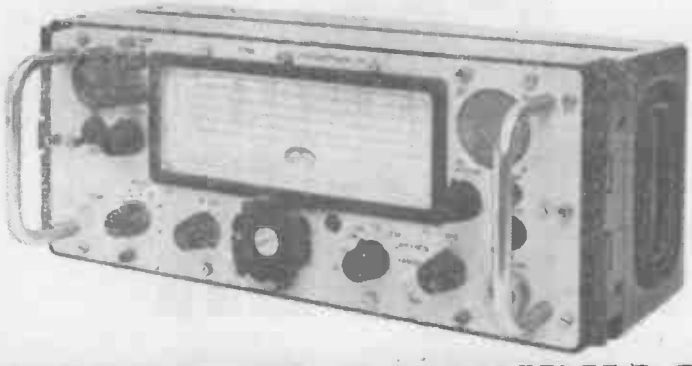

this set is unique!

Designed by C & N (Electrical) Limited as a compact, robust, reliable equipment, this sophisticated set stands alone in its field. Whatever the environment, this Receiver will remain operational – powered by standard U2 torch batteries, vehicle batteries, field generator or mains supplies. Tough assignments require dependable equipment.

R7020 HF COMMUNICATIONS RECEIVER

FULLY TRANSISTORISED - FREQUENCY RANGE OF 0.6 to 32 Mc/s.

Any portable Receiver offering the detector outputs which this set has available, capable of operating under the most adverse environmental conditions, and designed particularly with hard usage in mind, has so far been cumbersome, unwieldy and unsuitable for prolonged manhandling. This set marks a major step forward in British communication equipment and was selected for use by the 1964/65 British Combined Services Expedition to South Georgia, Antarctica.

Brief Technical Summary – Crystal calibration at 100 Kc/s intervals. Frequency selection: 11 x 3 Mc/s Bands. Power Supply: Between 12 and 50 V DC at 100 mA (peak). Signal Modes: AM, PM, SSB, FSK, & CW. Co-axial or Wire Aerial connections. Total Weight: 20 lbs. The Receiver is housed in a standard R.A.E. aluminium alloy Equipment Case and has been accepted by the British Ministry of Defence.
(See it at the 1965. R.E.C. Show on Stand No. 318)

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0.5 KVA TO 250 KVA

TRANSFORMERS

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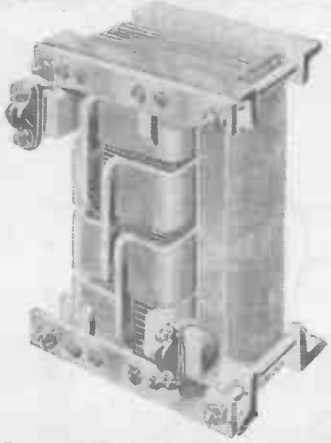

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Output currents of hundreds or thousands of amperes for Furnaces, Rectifier Sets, Heat Runs, Short Circuit Testing and other uses.

Examples: 5V300A.
10V1,000A
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64 STEP ON LOAD SWITCHING AUTO-TRANSFORMERS

Output 1.6% to 100% or 125% of input volts in 64 steps or 80 steps. A control device for many loads — resistance furnaces, rectifier sets, battery charging, anodising, heating and other uses 1 Phase and 3 Phase. 18 Models.

Output currents from 20 A to 200 A.

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No establishment is too large or too small for this system and it has been specially designed for use where intrinsic safety regulations apply.

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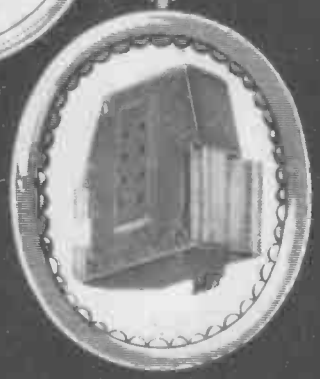
MINIATURES from Airmed Ltd



Rugged high performance carbon microphones for communication use. They can be mounted on headset booms where small size and weight are obvious advantages. Both types can also be mounted in various ways to meet individual requirements.

These microphones are designed for close speaking where the special acoustic screens, high electrical output and tailored frequency response make an important advance in speech transmission.

SPECIFICATION	A 301	A 303
Frequency response	200-5000 c/s	200-4000 c/s
Sensitivity	—50dB/V/dyne/cm² at 1000 c/s	
Load Resistance	100 to 250 ohms	100 to 250 ohms
Feed Current	Approx. 40 mA 60 to 85 mA s/c current	
Mounting	By two 8 BA screws which also form the contacts.	Special clip contact for mounting on headset boom.
Finish	High impact injection moulded case. Hermetically sealed except for small equalising leak. Fully tropicalised.	

LEAD SWITCH

ARB Ref. WR650

A spring loaded single pole double throw snap-action positive contact switch, designed primarily as a microphone switch for airborne telecommunication headsets.

RATINGS: D.C. 28 v. D.C. max. at 100 mA.
A.C. 240 v. A.C. at 2 A.

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COMPLETE SEWING MACHINE MOTOR OUTFITS. No better job obtainable any price. 200/250 v. A.C./D.C. Fitted latest radio/T.V. suppressors. Comprising motor with fixing brackets, foot control and switch, needle light with switch, belt, etc. and instructions for easy fixing to ANY machine. The complete outfit £6/18/6 (des. 3/6).

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VENNER CLOCKWORK DELAY SWITCHES. Variable ½ to 8 hours. Make, break or C.O. Easily set calibrated dial. 5 amp switching. Panel mounting. 2in. dia., 2¼in. Long. Ideal for Parking lights. 37/6. (des. 2/-).

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EXTRACTOR FANS. Final offer of this very popular and efficient model complete with outside cowling and indoor shutter. Circular motor housing only 4½in. dia. Easily mounted in small window pane. Silent induction motor. 200/250 v. A.C. (no interference), 3,500 c.f./hr. Instructions with each. Only 69/6 each (despatch 3/6). We also supply our 8in. model at £5/5/- and 10in. model at £5/12/6 (despatch 3/6). These models are not supplied with outside cowling. Details on request.

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The OXLEY printed circuit sockets are designed for direct mounting on "I" module printed circuit board with standard ·050" diameter holes and accepts our standard plug Type 50P/156. The mounting is arranged so that the plugs may be inserted in a plane parallel to the printed circuit board thus permitting close stacking of circuit boards.

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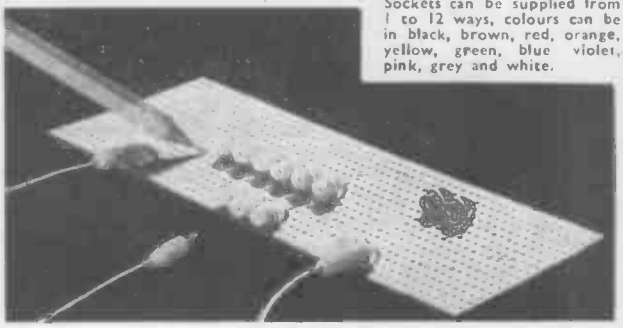

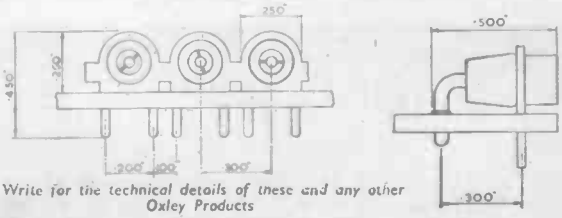

Write for the technical details of these and any other Oxley Products

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OXLEY DEVELOPMENTS CO. LIMITED

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STAND 218

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All output and input terminations are fully floating, thus enabling layman or skilled engineer to be equally confident in the simple matter of coupling up for use.

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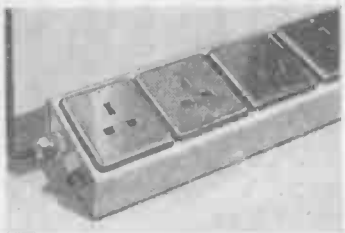

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S9IT silicon junction transistor similar to OC204 V_{CB} max. = V_{CE}max. = −14V; $I_E$max. = 450mA; I_B max. = 90mA; I_{CO} (V_{CE} = −6V) <0.3μA; fl (V_{CE} = −6V, I_C = 1mA) = 1.5 Mc/s.; h_{FE} >14.

S3R germanium general purpose point contact diode. P.I.V. 22V.

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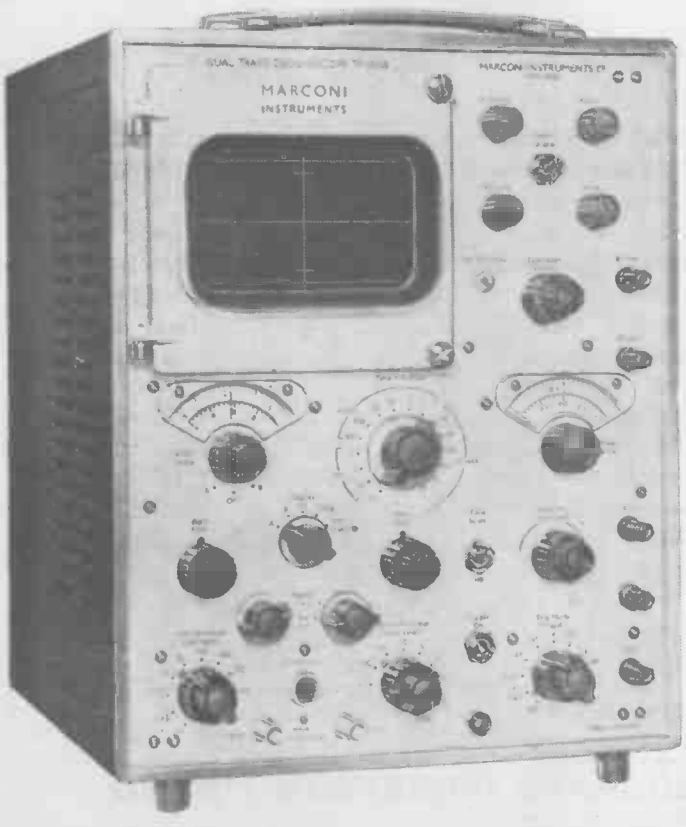
Unique? Yes, we think so. This is a general purpose oscilloscope with a 3dB bandwidth of *at least* 15 Mc/s. The d.c. coupled amplifier has a response which is practically flat to 10 Mc/s with a very gradual roll-off up to 30 Mc/s. *This really is a 15 Mc/s scope* with a writing speed that can cope with fast pulses. The 5-inch CRT has a spiral post-deflection accelerator and is operated at an e.h.t. of 10 kV. *You can really see the leading edge of a fast pulse on the TF 1331A.*

And what other oscilloscope at this price—£400—has all these features?

☐ Slide-back measurement of time and amplitude by means of directly-calibrated shift controls, giving measurement accuracy independent of amplifier gain and CRT sensitivity ☐ 250 nsec signal delay, enabling you to view the leading edge of the pulse that triggers the timebase ☐ Provision for use of the full range of Marconi oscilloscope accessories, including probes, viewing aids, and camera attachments.

MARCONI INSTRUMENTS
TYPE TF 1331A

DUAL TRACE OSCILLOSCOPE



* Bright display on fast sweeps
* Full 15 Mc/s bandwidth
* Direct time and amplitude calibration
* Signal delay
* Cathode-follower probe

Please write or 'phone for full technical information.

A GOOD NAME FOR GOOD MEASURE

MARCONI INSTRUMENTS

Marconi Instruments Limited, St. Albans, Herts.
Tel: St. Albans 59292. Telex 23350

FC 282

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FOR ELECTRICAL INSTRUMENT AMPLIFICATION · PUBLIC ADDRESS · SPECIALISED APPLICATIONS

Outstanding in the Goodmans Audiom range is the 18 inch Audiom 91. Very large numbers now in use under the most punishing conditions give ample evidence of the reliability of this unit, due in large measure to the use of a 3" voice coil, for increased heat dissipation, a massive magnet system for high control and efficiency, and a very strong cast chassis to stand inevitable severe handling. The diaphragm too is particularly durable, and provides excellent performance for critical musical applications, just as for purposes requiring sheer power.

The Audiom 91 is available in two versions: Audiom 91 STANDARD for use with Bass Guitars and in high power Public Address and sound reproducing systems; Audiom 91 BASS for use with Electronic Organs, in specialised applications, and as a Bass unit in very high powered multiple speaker High Fidelity Systems.

The heavy duty Audiom 91 handles up to 50 watts (100 watts U.S.A.) of power (35 watts when used with Bass Guitars).

AUDIOM 91

SPECIFICATION

Maximum Power handling capacity	50 watts (100 watts U.S.A.)
Fundamental resonance (nominal)	Standard 55 c/s
Fundamental resonance (nominal)	Bass 30 c/s
Flux density	14,000 gauss
Total flux	269,000 maxwells
Voice coil	3" (7.6 cm) diameter
Impedance	15-16 ohms
Chassis	Diecast
Overall diameter	$18\frac{1}{16}$" (45.89 cm)
Overall depth	$8\frac{1}{8}$" (20.6 cm)
A.R.U. 480 enclosure volume (internal)	11,700 cu. ins.
Baffle hole diameter	16" (40.64 cm)
Fixing holes	8 holes $\frac{11}{32}$" (.87 cm) dia. on $17\frac{1}{4}$" (43.82 cm) PCD
Net Weight	22 lbs (9.98 kg.)

For full details of the Audiom 91 and its many applications, and the other units in the Audiom range, contact
Technical Advisory Department

GOODMANS

GOODMANS INDUSTRIES LIMITED
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31.6V ✓

10c/s to 1Mc/s

✓ **Low Distortion**

Marconi Instruments Type TF 1370A

WIDE RANGE R-C OSCILLATOR

A new development in versatile sine-wave/ square-wave generators

- Sine-waves 10 c/s to 10 Mc/s Square-waves 10 c/s to 100 kc/s
- Distortion less than 0.5% over main part of range
- Decade frequency bands with dual-ratio slow-motion tuning
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- Price — £275
- Accessories include a triple impedance unbalanced-to-balanced transformer, 1 kc/s band-pass filter and x 100 attenuator pad

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MARCONI INSTRUMENTS

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Also available shortly—Signal Source Calculator (slide rule)

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TC 283

The revolutionary Tweeter —introduced at the Audio Fair—and available now!

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LOUDSPEAKER

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The basic H.F. unit ready for building into a speaker assembly. It will handle the treble of 20 watts of music.
28 Gns.

MODEL 602

The basic Ionofane: H.F. unit, together with a special 5" mid range unit, cross-over and provision for connection to an existing bass unit of up to 20 watts capacity.
45 Gns.

MODEL 603

A full range speaker assembly of the highest quality, consisting of the Ionofane H.F. unit, new 5" mid range and new 15" bass unit. Will handle up to 20 watts.
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The IONOFANE operates on the Ionophone principle invented by Klein of Paris and is covered by British Letters Patent No. 756546. It is a high frequency loudspeaker having a perfectly uniform response from 3 to 30 kilocycles, quite free from resonances and colourations and with perfect reproduction of transients. It is fully guaranteed.

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Measurement of Harmonic Distortion

One of the most essential measurements necessary in a high quality audio system is that of simple harmonic distortion. It is impossible to do serious development work on anything in high quality audio without measurement of this fundamental parameter.

RADFORD make the most advanced audio equipment in the world, and in order to do this it was found necessary to develop measuring instruments of a superior performance than those existing. The Low Distortion Oscillator and Distortion Measuring Set were designed by audio engineers knowing the requirements of such apparatus in audio engineering.

The Low Distortion Oscillator generates sine waves of extreme purity from 5 c/s to 250 Kc/s. The instrument also contains a valve millivoltmeter, a squareing circuit which will produce a clean 250 Kc/s square wave, and a switched 'T' 110 dB 600 ohm attenuator with facilities for continuous interpolation. The distortion of the oscillator is less than 0.005% at mid-band frequencies from its 600 ohm output attenuator. It is also capable of a very low distortion output of about 0.001% or below from the 10K ohm output position at mid-band frequencies.

The Distortion Measuring Set is a complementary equipment, and is capable of measuring extremely low distortion content. The most sensitive range on the instrument is 0.01% f.s.d. On this range it is possible to get an accurate measurement of 0.002% distortion and an indication of the order of 0.001% distortion.

The design of these instruments is described in leaflets which are available upon request.

Prices: Low Distortion Oscillator. **£95.**
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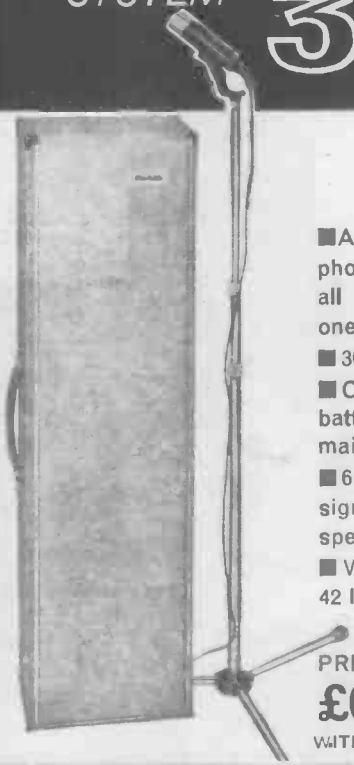

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Tel: Idle 1235/6
Grams: "Wharfdel" Bradford

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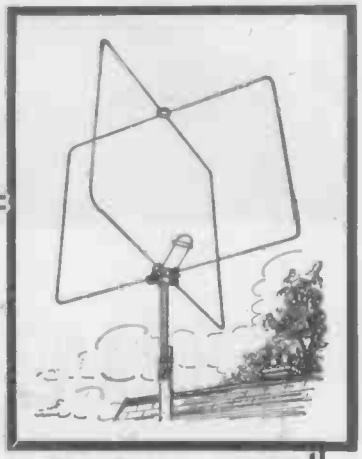

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- High Gain (+9.5dB) with high Front to Back (−35dB) and Front to Side (−30dB) ratios.
- Full wavelength elements reduce interference
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(TRANSISTORISED D.C. CONVERTERS)

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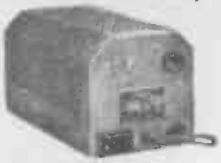

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18th—21st MAY

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The vital role of reliable communication

When reliability is of the first importance—as with ambulance or patrol car work—BCC equipment is chosen time and time again. The BCC 81 mobile VHF transmitter-receiver is so compact that the whole unit can be fitted under the dashboard of almost any vehicle, without taking up valuable passenger space, thereby adding prestige and efficiency. Transistors are used throughout the receiver and power supply unit and in all but the final stages of the transmitter; current consumption is low—equal to only one instrument panel lamp on 'receive'; no standby facility is necessary as quick heating valves are used in the transmitter.
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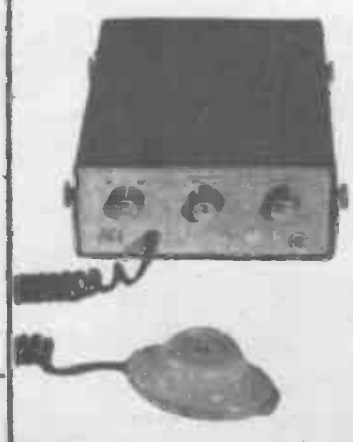
BCC 81



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LOW FREQUENCY SIGNAL GENERATOR
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10c/s to 100kc/s in four decade ranges

Three Outputs:

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3) 0 to 1 Watt into 3 ohms, 50c/s to 20kc/s

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Send Coupon, deleting as required.

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Please supply Low Frequency Signal Generator Type G.1. Cheque for £20 enclosed.
Please send Type G.1. Technical Leaflet.

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Address .....

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PRODUCTION

- Closed circuit television
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Italian representative and licensee of TELEFUNKEN AG
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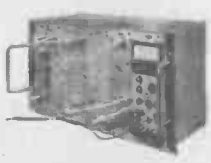

Transistorised television repeater P 3149

Direction unit for large sound diffusion installations

Transistorised telecamera-P 4814

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THE AWA TRANSMISSION MEASURING SET — A220

An accurate, portable instrument for the evaluation of audio and carrier frequency systems.

- Compact, transistorised and ruggedly constructed, the instrument is ideal for field or station use.
- All major circuits are plug-in epoxy glass-fibre printed boards.
- Accuracy and high-stability have been retained by the use of tantalum electrolytic capacitators and deposited metal-film resistors.
- Unit may be operated from A.C. Mains, external D.C., or internal rechargeable cells.

For further particulars, please contact Engineering Products Division.

FUNCTIONS OF THE A220 (provisional)

- Measures signal level of transmission equipment, between 50 c/s and 250 kc/s; impedances of 75, 150, 600, 1,200 ohms. Terminating and bridging level measurements with balanced input.
- High-impedance voltmeter (unbalanced), 50 c/s to 650 kc/s. 1 Mohm input, sensitivity 10 mV, F.S.D.
- A balanced frequency-selective voltmeter to measure pilot carrier level and "Tone-on-channel" selection. Bandpass 100 c/s.
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- Wien-bridge, sine-wave oscillator, frequency continuously variable over range 100 c/s to 630 kc/s. With associated amplifier outputs to +13 dbm in 75, 150, 600, 1,200 ohms (balanced).
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- Meter indicates modulation percentage on carrier channels (8 kc/s to 250 kc/s).
- Weighted noise measurements (with optional external plug-in unit) to C.C.I.T. Specification or other network if required.
- Simulates broadband carrier channels with a.m. modulation.
- Wave analyser measures harmonic distortion and intermodulation products down to 0.1%.
- Amplitude modulation monitor, 0 to 80%.
- Measures the bandpass characteristics of filters.
- Provides output for Pen recorder (0.1 mA 1,000Ω) or head receiver for listening tests.

Dimensions and Weight:

Height: 8 inches 20.3 cm. *Width:* 14 inches 35.5 cm. *Depth:* 12.5 inches 31.75 cm. *Weight:* 20 lbs. 9 kg. (approx. including power supply).

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EP7-65

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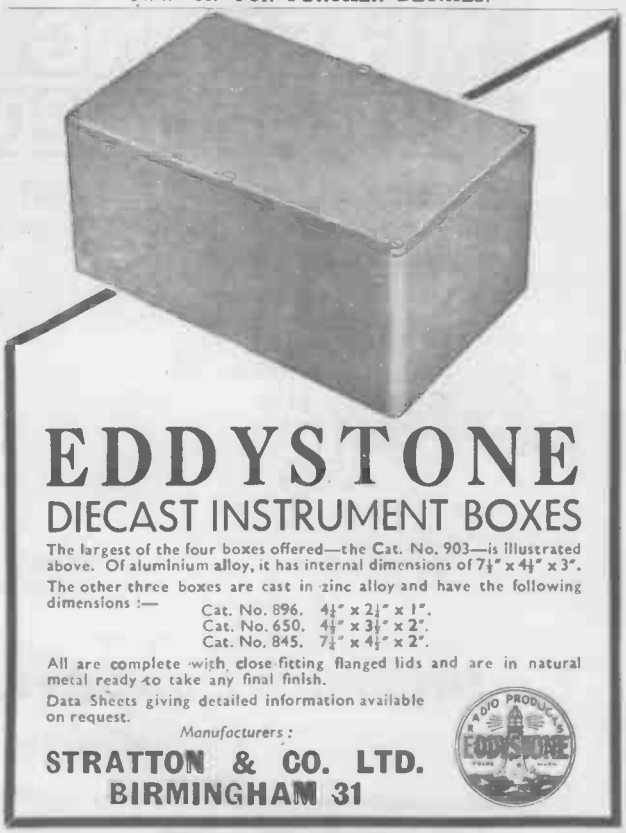

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The largest of the four boxes offered—the Cat. No. 903—is illustrated above. Of aluminium alloy, it has internal dimensions of 7½" x 4½" x 3".

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AN ORIGINAL BRITISH DESIGN FOR WORLD MARKETS ...

Illustrated is the LSP 30 Pack Set.
25 Watts p.e.p. output
2-11 Mc/s.
Totally transistorized USB/LSB and compatible A.M. complete with unique continuously tunable aerial.
Ruggedised and Tropicalised for use all over the world.

Also available:

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Plus a range of continuously tunable Whip Aerials (patents pending)

Labgear Transistorised SSB Transceivers give you the Ruggedness and Dependability of military designs but at the cost of units made for commercial applications. One standardised Receiver/Exciter module is the heart of every equipment resulting in lower initial cost and better serviceability

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TWO-WAY RADIOTELEPHONE

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RADIOTELEPHONE SSB 125

The world's most competitive Single Sideband Radiotelephone—the SSB 125 is suitable for fixed or mobile operation and is the most economic equipment for long distance communication available today.

Features

- 125 watts p.e.p. output
- 4 switched channels
- Transistor DC or AC power pack
- Crystal filter selection of sidebands

PYE TELECOMMUNICATIONS LTD.
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Telephone: Teversham 3131

SWW—073 FOR FURTHER DETAILS.

THE LINEAR 'SUPER 30' HIGH FIDELITY PUBLIC ADDRESS AMPLIFIER

TECHNICAL DETAILS:

SENSITIVITY FOR 30 WATTS
Gram.—50 millivolts.
Mic. 1. 5 millivolts.
Mic. 2. 150 Microvolts.

FREQUENCY RESPONSE
± 2 dB 30 c.p.s.—20,000 c.p.s.

BASS CONTROL
+ 15 dB to — 15 dB at 50 c.p.s.

TREBLE CONTROL
+ 12 dB to — 12 dB at 10 Kcs.

HUM AND NOISE
— 60 dB

HARMONIC DISTORTION
0.5% for 30 watts.

VALVES
Mullard ECC83, ECC83, ECC83, EL34, EL34, GZ34.

NEGATIVE FEEDBACK
20 dB

DAMPING FACTOR
12

RETAIL PRICE **33 Gns.**

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For operation on standard 200-250 v. 50 c.p.s. A.C. mains. 110/120 v. models available for export.

Trade and export enquiries invited.

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A HIGHLY EFFICIENT 30 WATT GENERAL PURPOSE PUBLIC ADDRESS UNIT

With input mixing facilities and outputs for 3 - 7·5 - 15 and 330 ohms (100 volt line).

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Three high sensitivity standard Jack inputs with provision for high and low impedance microphones.

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EFFECTIVE RESISTANCE LESS THAN 1 ohm.

TYPE 250VRU/30/20
PRICE £131-5-0

FEATURES **0-30 VOLTS Variable up to 20 AMPS.**

RIPPLE CONTENT negligible, **IMPEDANCE** and **REGULATION** equivalent to accumulator performance. **SILICON RECTIFIERS.** Inadvertent **"SHORT"** protection.

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Valradio LIMITED

STAND 113 R.E.C.M.F. SHOW MAY 18-21

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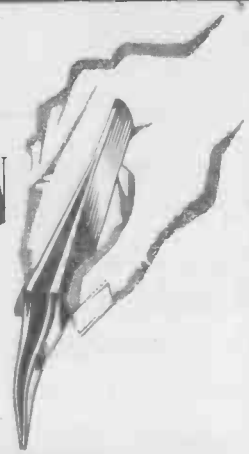

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over SIXTEEN MILLION frequency characteristics

at your fingertips—each one repeatable, quickly, visibly and accurately to within 1 dB!

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840C
£62

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Ranges 4 and 5 include the International Distress Frequencies. Sensitivity better than 10 microvolts. Selectivity 30 db down at 10 kc/s. off resonance. A.C./D.C. Internal speaker.

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940	£125 0 0	£25 0 0	£8 16 6	£4 14 6
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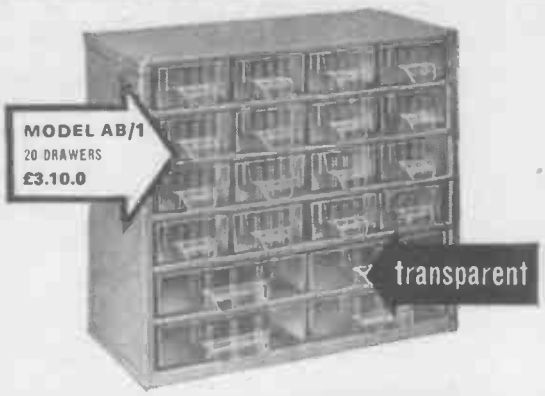

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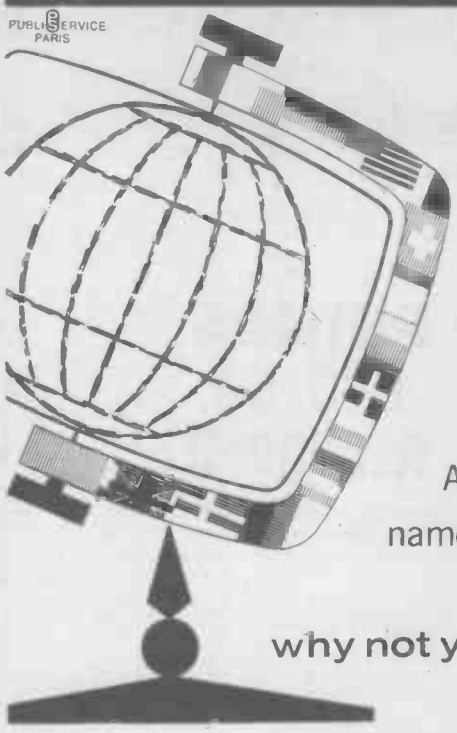

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from 9—19 September, 1965

PARIS

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FIRM: .....

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PRODUCTS: .....

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SIGNATURE:

POSITION IN FIRM: .....

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(Provisional Patent No. 06155)

RELATING TO ELECTROSTATIC LOUDSPEAKERS

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The unit will be incorporated in the new "DYNASTATIC Mk. II" Loudspeaker.

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These new loudspeakers are now available and are being demonstrated here in Barnet. All interested are invited to see and hear what is now probably the world's finest loudspeaker at a price people can easily afford.

Write or ring BARnet 6605.

AUDIO SERVICES LTD.

82 East Barnet Road, New Barnet, Herts
No parking problems. Open Saturday until 7 p.m.

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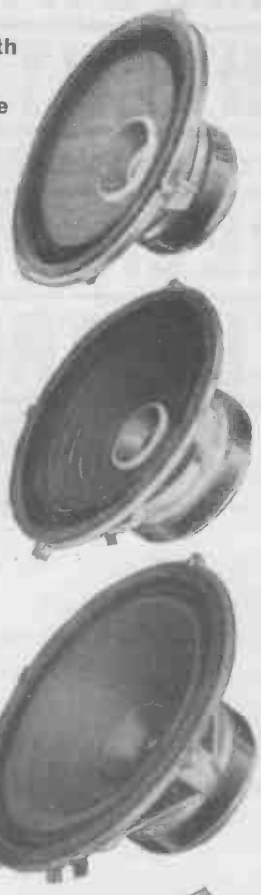
Each loudspeaker in this range is fitted with roll surround for low resonance and double diaphragm assembly for extended HF response.



SUPER 8/RS/DD

Impedance 10/15 ohms
Ceramic Magnet
Flux density 14,500 oersteds
Total flux 60,000 maxwells
Aluminium voice coil
Max. input 6 watts rms or 12 watts peak
Frequency range 40-20,000 c/s.
Bass resonance 50/60 c/s.
Price 134/2 inc. P.T.

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Flux density 16,000 oersteds
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Total flux 190,000 maxwells
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Wharfedale

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PHILIPS PRO 50 RECORDER

These are some of the features that make this new series of recorders particularly suitable for editing—although they are of course completely versatile:

1. Models for 7½/15 i.p.s. or 15/30 i.p.s.
2. One or two tracks on ¼in. tape, 3 or 4 tracks on ½in. tape.
3. CCIR or NARBT tape feed and equalisation.
4. Ferrite heads for long life, maintained quality, precise alignment of multiple gaps, and easy maintenance.
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7. Finger gaps in headblock for ease of tape handling.
8. Tape lifted during rewind from all heads or in contact with play-back head only if required.
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The PRO 50 is one of a new range of Philips Tape Recorders which covers every requirement of high grade professional sound recording: the PRO 20 transportable; the PRO 25 for highest quality studio recording; the PRO 50, particularly suitable for heavy duty operation; and the PRO 70 for multi-channel recording and for dubbing, post-synchronising and transfer.

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SOUND & VISION SYSTEMS

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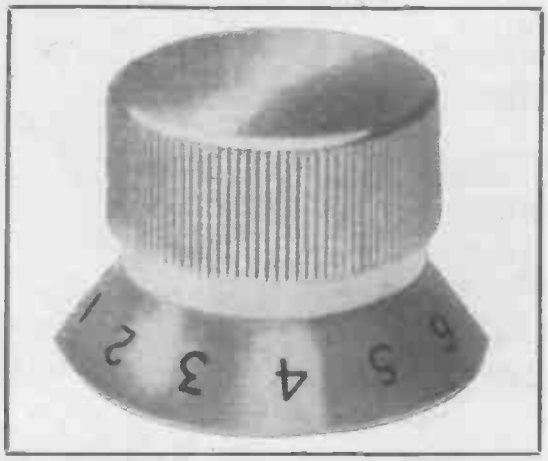

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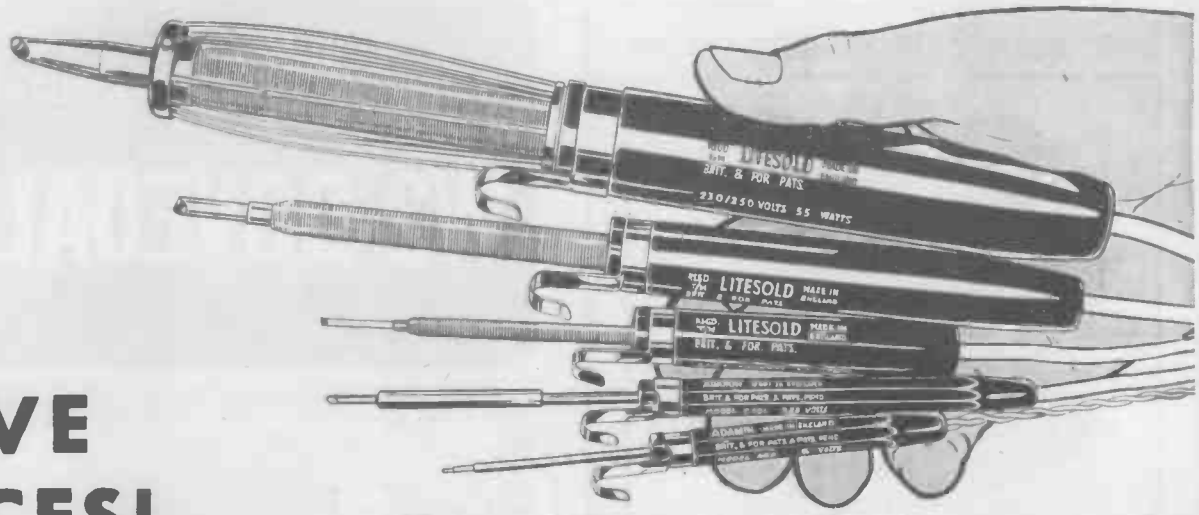

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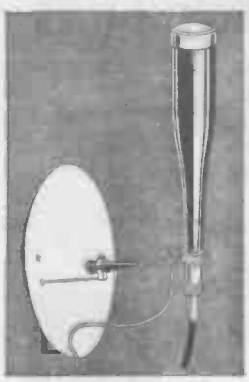

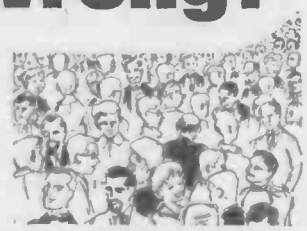

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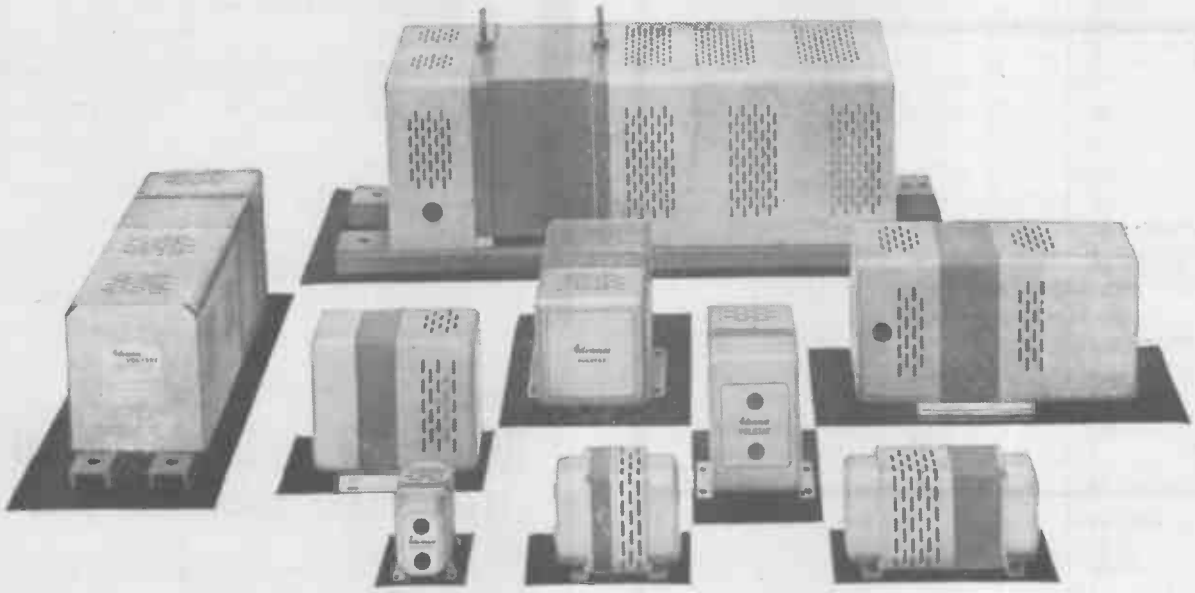

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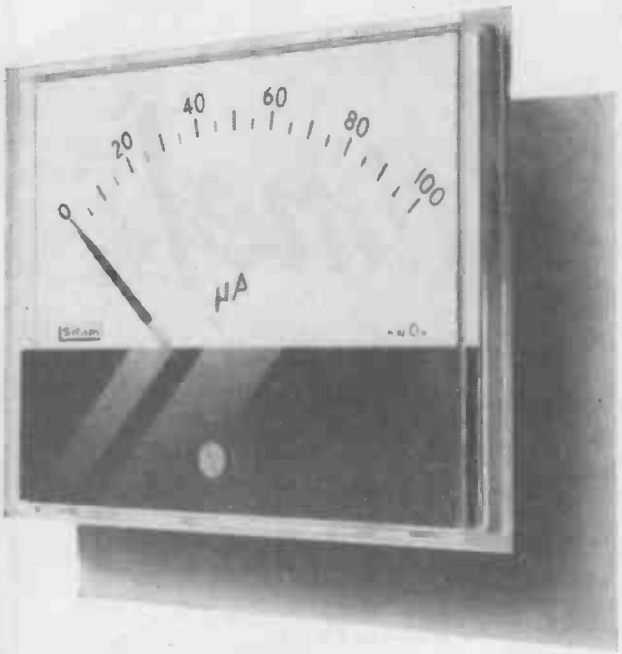

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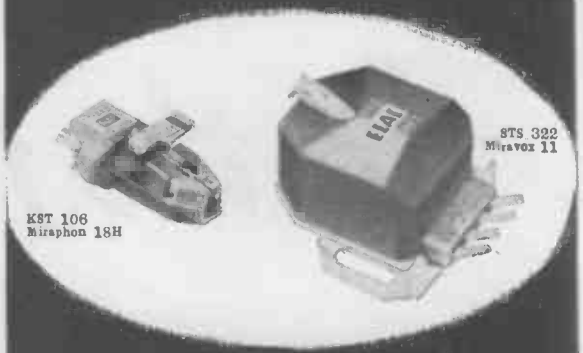

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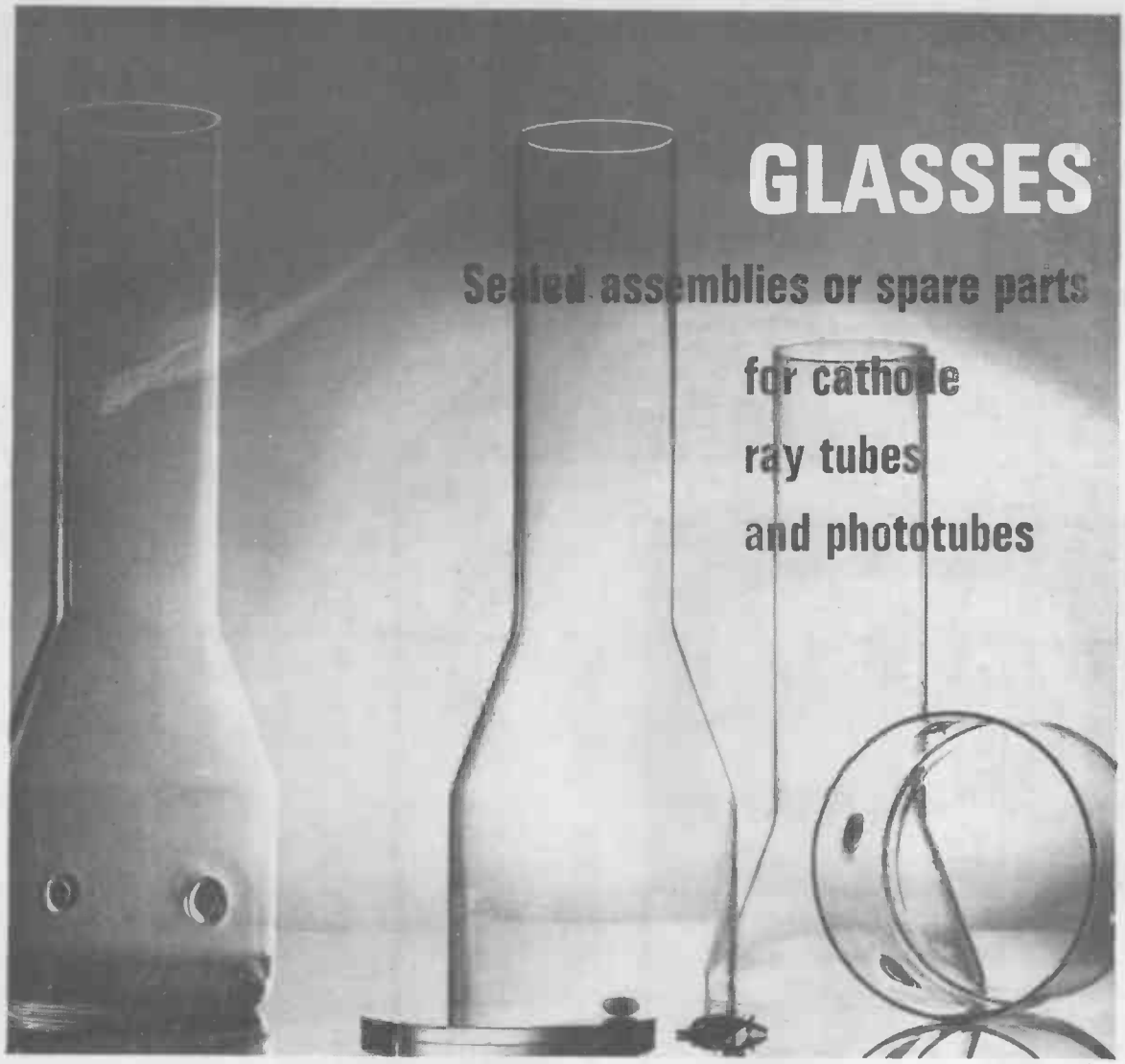

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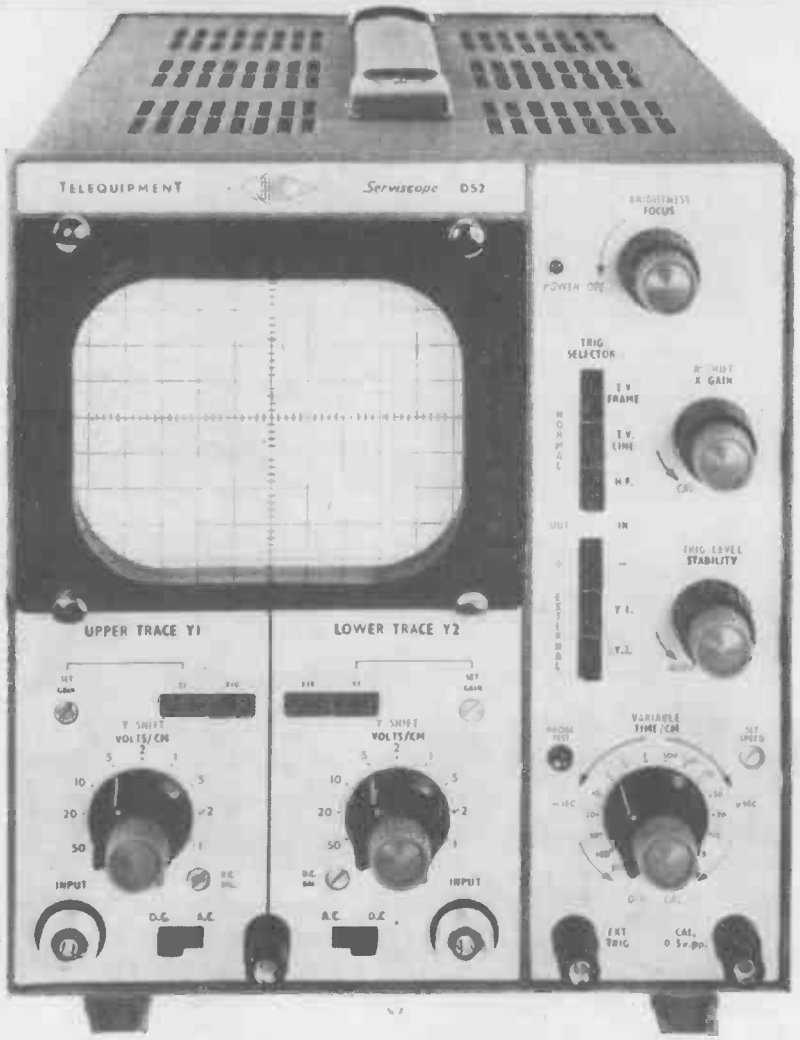

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Wireless World

ELECTRONICS, TELEVISION, RADIO, AUDIO

MAY 1965

209 Editorial Comment
210 A Single-Carrier Colour Television System — *By E. J. Gargini*
213 Duality — *By "Cathode Ray"*
217 Books Received
218 I.F. Sweep Generator — *By M. W. Rignall*
220 Cathode Emitter and Decoupling — *By J. F. Young*
223 Manufacturers' Products
229 World of Wireless
231 Personalities
233 News from Industry
235 50 Years of Public Address
237 Physics Exhibition in the North
243 Paris Components Show
245 Colloquium on Memory Techniques
246 Letters to the Editor
249 Satellite Communications Service Begins
251 Electronic Laboratory Instrument Practice—5 — *By T. D. Towers*
256 This Month's Conferences and Exhibitions
257 May Meetings
258 Logic Circuits
258 H.F. Predictions—May

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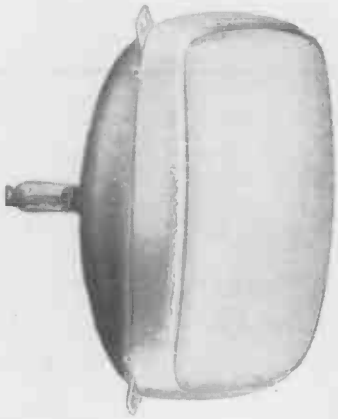

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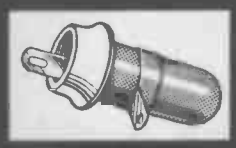

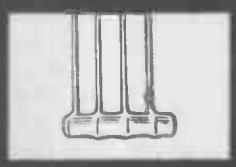

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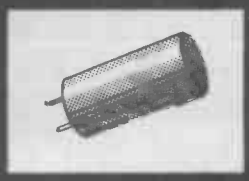

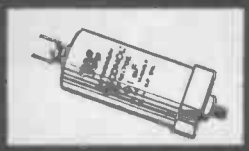

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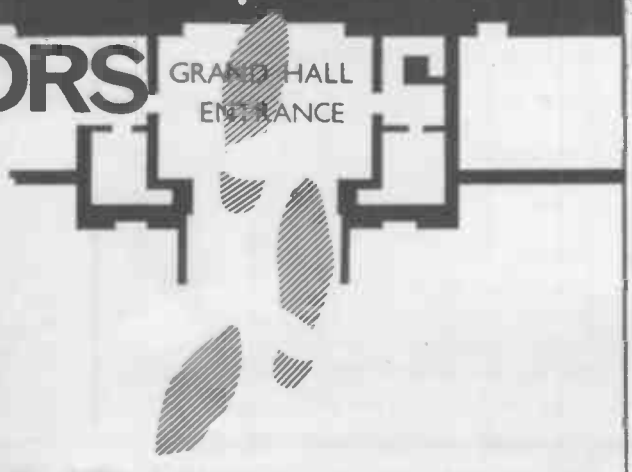

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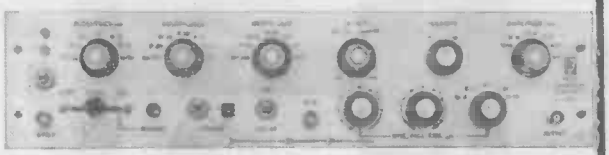

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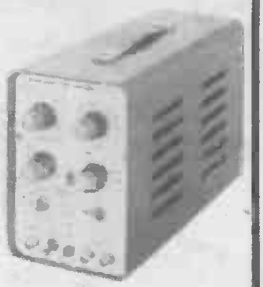


Other Models:
SG-1 Square Wave Generator
PU-2 Externally-Triggered Delay & Double Pulser

Optional Single- and Multiple-Unit Rack Adapters Available.

HSA-1 Subsonic Spectrum & Wave Analyzer

frequency range 1 to 4000cps ■ resolving power 1cps; 5cps at 55db amplitude difference ■ linear and log amplitude scales wave and automatic sweep operation ■ odometer frequency indication with 1% accuracy ■ linear sweep voltage output ■ remote sweep control ■ sinusoidal analysis frequency output ■ readout on standard plotter or recorder

HSA-2 Audio Spectrum and Wave Analyzer

frequency range 20 to 30,000cps wave and automatic sweep operation ■ odometer frequency indication ■ selective filters: 10 and 200cps ■ linear and 60db log amplitude readout ■ sinusoidal analysis frequency output ■ automatic frequency tracking ■ linear electronic sweep output ■ crystal-controlled markers ■ readout on standard plotters, recorders or oscilloscopes

RSA-1 Random Signal Analyzer

power spectral density, probability density and cumulative probability distribution modes ■ linear and logarithmic output: instantaneous voltage, voltage squared, integrated voltage, or integrated voltage squared ■ frequency range (with appropriate Intercontinental Spectrum Analyzer) to 30kc ■ synchronized for continuous tape loops ■ amplitude and frequency readout on standard XY plotter or scope

Optional Rack Adapters and Companion Recorders Available.

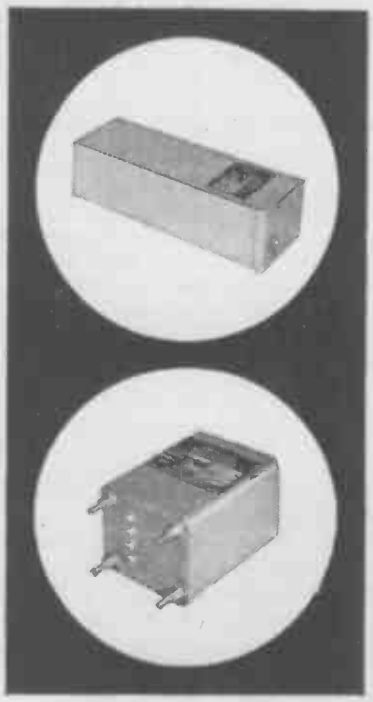
CLAUDE LYONS

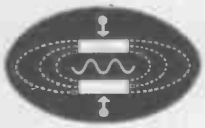
CLAUDE LYONS LIMITED · INSTRUMENTS DIVISION
76 Old Hall Street, Liverpool 3 MARitime 1761
Southern Offices; Valley Works, Hoddesdon, Herts. (Hoddesdon 4541)

5WW—104 FOR FURTHER DETAILS.

PRECISION OSCILLATORS

As designers and as users of oscillators, Marconi set an exceptionally high standard in accurate frequency control. Years of experience give Marconi authority in the production of crystals, crystals with ovens, and complete oscillators.
The new Marconi range of packaged, transistorized, highly stable, pre-tested, quartz crystal oscillators, using conservatively rated silicon transistors, is available within the frequency range 1 kc/s to 75 Mc/s.





Marconi specialized components are designed and manufactured only when the precision and high performance required is otherwise unobtainable.
The Specialized Components catalogue lists the full range.

Marconi specialized components

The Marconi Company Limited, Specialized Components Division,
Billericay Works, Radford Crescent, Billericay, Essex, England.

LTD/FS7

5WW—105 FOR FURTHER DETAILS.

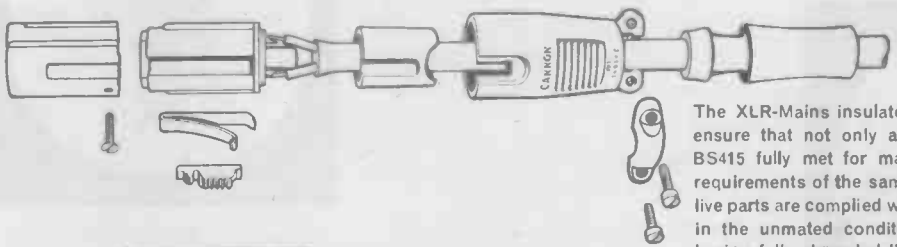
NUMBER ONE IN ELECTRICAL CONNECTORS... 1

NEW XLR MAINS CONNECTOR

(APPROX. FULL SIZE)

New versatility

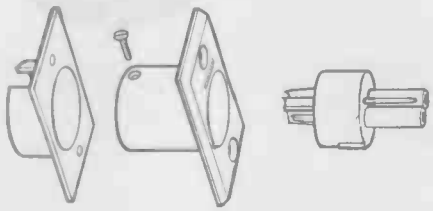
Cannon has developed a mains version of the already well established range of high quality audio XLR connectors with latch/lock coupling. This will permit the standardisation by equipment manufacturers and users, of a common type of connector which covers both audio and mains input applications. The XLR-Mains is suitable for cable rated at 2 amps and fully meets the Safety Requirements of BS415. The XLR mains was designed at the specific request of the BBC.



The XLR-Mains insulator has been carefully designed to ensure that not only are the creepage requirements of BS415 fully met for mains voltages but that the safety requirements of the same Specification limiting access to live parts are complied with by *both* halves of the connector in the unmated condition. This has been achieved by having fully shrouded line and neutral socket contacts in the receptacle insert and deeply recessed and shrouded corresponding pins in the plug. The earthing connection is made by a pin contact in the receptacle and by a socket contact in the plug; both the earth contacts are connected directly to the outer shell. By having both pin and socket contacts in each half of the connector and by the shrouding given to the line and neutral contacts, mismating of the mains version with any of the audio versions is prevented. In addition, to provide immediate visual discrimination between the XLR Mains and the XLR Audio series, in both the unmated and mated condition, the insert mouldings and cable bushing of the mains connector are coloured red.

(APPROX. FULL SIZE)

An insulating shroud is available for the XLR-LNE-32 fixed receptacle. This permits electrical isolation of the metal receptacle body from the panel when the prevention of earth loops is desirable. The XLR-LNE connector is fitted with the latch/lock type coupling which is standard on the XLR range.



For any connector requirement consult the world's most foremost name in this highly specialised field.

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STAND 325
GRAND HALL OLYMPIA

BRIMAR

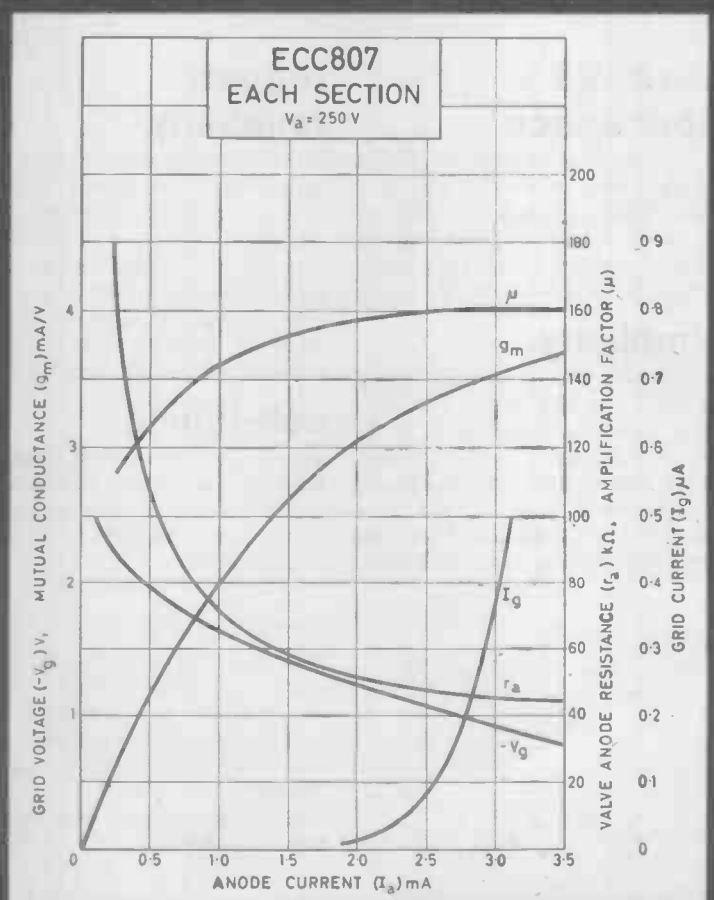
high μ
DOUBLE TRIODE

Particularly suitable for Tape Recorders and Instrumentation

HIGH GAIN
Amplification Factor μ.150

LOW NOISE
Grid Hum Level 3μV

Better make it BRIMAR



Please ask for Data sheets

Thorn-AEI Radio Valves & Tubes Ltd.

HEAD OFFICE: 155 CHARING CROSS ROAD · LONDON, W.C.2 Telephone: GERrard 9797

BRIMAR EXPORT DIVISION: THORN HOUSE · UPPER ST. MARTIN'S LANE LONDON, W.C.2

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Marconi Self-Tuning H.F System
—the first in the world to be station planned from input to output

MST

breakthrough

MST 7½kW transmitter H1100 series

An h.f linear amplifier transmitter for high-grade telecommunications.
Frequency range: H1100 and H1101, 4—27.5 Mc/s
H1102 and H1103, 2—27.5 Mc/s
Output power: 7—8 kW p.e.p, 5—6 kW c.w.
The H1100 series meets all CCIR Recommendations.

saves 85% floor space

Transmitters can be mounted side by side and back to back or against a wall; built-in cooling fan; no external air-ducts. These features lead to smaller, simpler, cheaper buildings or more services in existing buildings.

simplicity

R.F circuits have only three tuning controls and two range switches. Final valve can be replaced in 30 seconds. Miniature circuit breakers (used instead of fuses throughout) can be reset instantly. All sub-assemblies are easily tested because they are electrically complete units.

rugged reliability

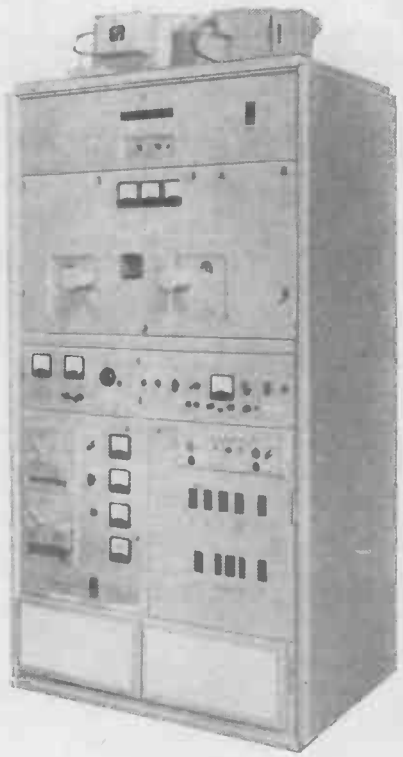
Stainless steel shafts in ball-bearings in rigid machined castings; stainless steel spur gears meshing with silicon bronze; heavy r.f coil contacts with high contact pressure—some examples of design features giving long term endurance and operational reliability. Specified performance achieved with ample margins.

self-tuning

Types H1101 and H1103, used with MST drive equipment, give *one-man* control of an entire transmitting station and continuous automatic aerial loading.

MANUAL TUNING

Manually tuned versions, types H1100 and H1102, are available which, when fitted with built-in drive units, become entirely self-contained transmitters for four spot frequencies and all types of modulation.
Manual tuning takes less than 60 seconds.

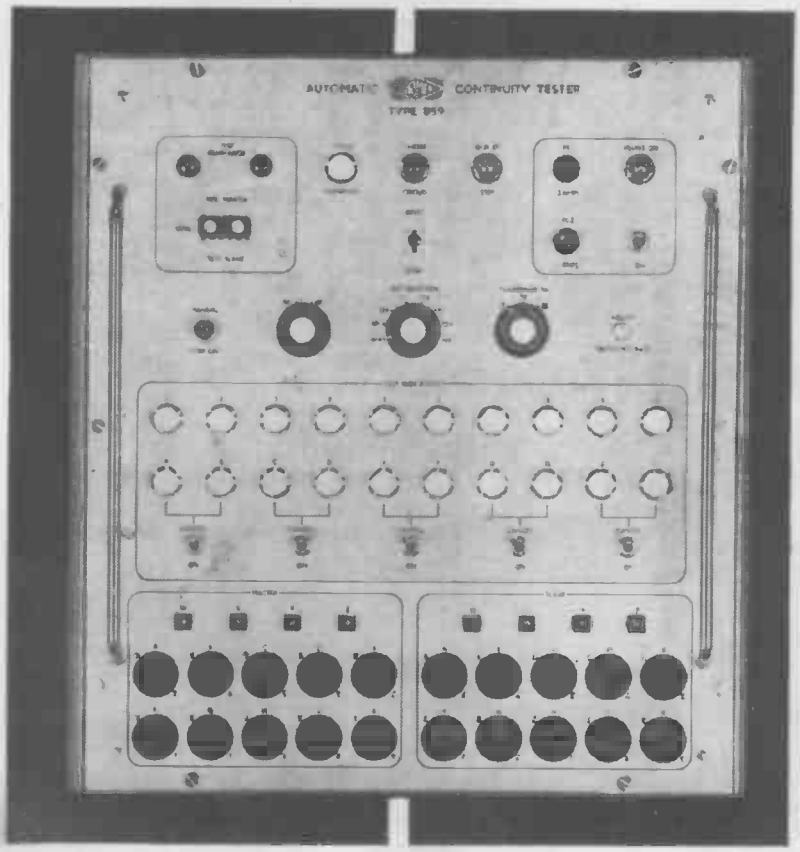


Marconi telecommunications systems

The Marconi Company Limited, Communications Division, Chelmsford, Essex, England LTD/H30
5WW—108 FOR FURTHER DETAILS.

Test 100 circuits...

...in less than 1 minute



Test Circuit:
Equal arm Wheatstone bridge for resistance comparison

Tolerance Ranges:
5%, 10% or 20%, set by front panel control

Test Rate:
Variable from approximately 3 per second to 1 per 2 seconds.

Test Voltage:
Max. bridge voltage 15 V d.c. or 7 V r.m.s. 50 c/s.

Test Capacity:
Up to 100 circuits with respect to any of four lines

This automatic circuit tester provides a rapid means of testing large numbers of electronic components in circuits and the associated wiring. The tester automatically switches from one circuit to another, checking the resistance of each against a 'master' unit.

Any circuit with a resistance outside the tolerances set on the front panel stops the testing sequence and shows a warning light.

By using the tester in conjunction with an Ohmmeter, such as the Airmec Type 861, 'fault' readings from the tester can be accurately measured as and when they occur.

Airmec Automatic Circuit Tester Type 859

Airmec for peak performance consistently

LABORATORY INSTRUMENTS DIVISION—
High Speed Counters, Signal Generators, Oscilloscopes, Wave Analysers, Phase Meters, Ohmmeters, Valve Voltmeters, etc.
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TELEPHONE: HIGH WYCOMBE 21201 (10 LINES)

AP 288

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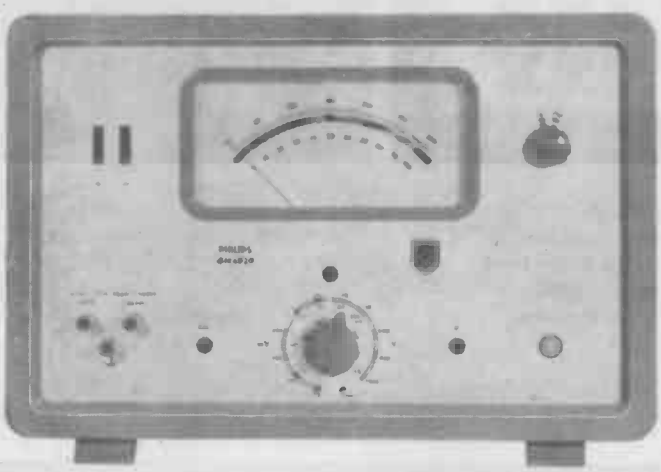
PHILIPS

PHILIPS

VERSATILE DC VOLTMETERS



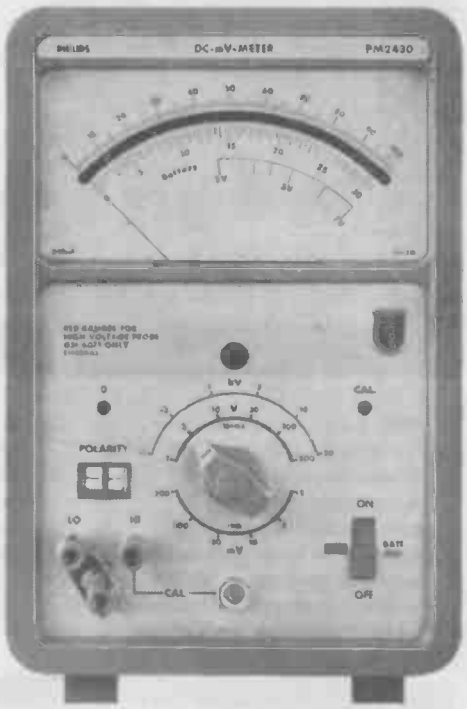
mains-operated
dc microvoltmeter GM 6020

The sensitive microvoltmeter of proved reliability
Measuring range: 100 μV (f.s.d.)-10 V in 11 sub ranges (input I), 10 mV (f.s.d.)-1000 V in 11 sub ranges (input II)
Accuracy: 3 % of full scale
Automatic polarity indication
Input impedance: 1 MΩ (input I), 100 MΩ (input II)
Pre-deflection: < 5 μV
Recorder output: 10 mV full scale
Dimensions: 25x36x22 cm (10x14x9 in), rack mount model available
Weight: 11 kg (24 lbs)

NEW

battery-operated
dc millivoltmeter PM 2430

The PM 2430 is a high-precision, fully transistorized millivoltmeter with either a floating or an earthed input.
The polarity of the dc voltage is automatically indicated on a small meter, which can also be used as a very sensitive null indicator. An internal calibration voltage, for easy re-adjustment, is provided.
Measuring range: 1 mV (f.s.d.)-300 V in 12 sub ranges.
Accuracy: 2 % of full scale
Input impedance: 1 MΩ (1 mV-300 V); 100 MΩ (1 V-300 V)
Pre-deflection: < 2.5 % of full scale in the most sensitive range
Polarity indication: automatic (from 3 % of full scale)
Null indicator: sensitivity approx. 5 μV
Power supply: 4 dry cells of 1.5 V or NiCd batteries
Dimensions: 24x16x18 cm (9½x6½x7 in)
Weight: 3.3 kg (7 lbs)



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electronic measuring instruments

Sales and Service all over the world
For the U.K.:
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207 Kings Cross Road, London WC1

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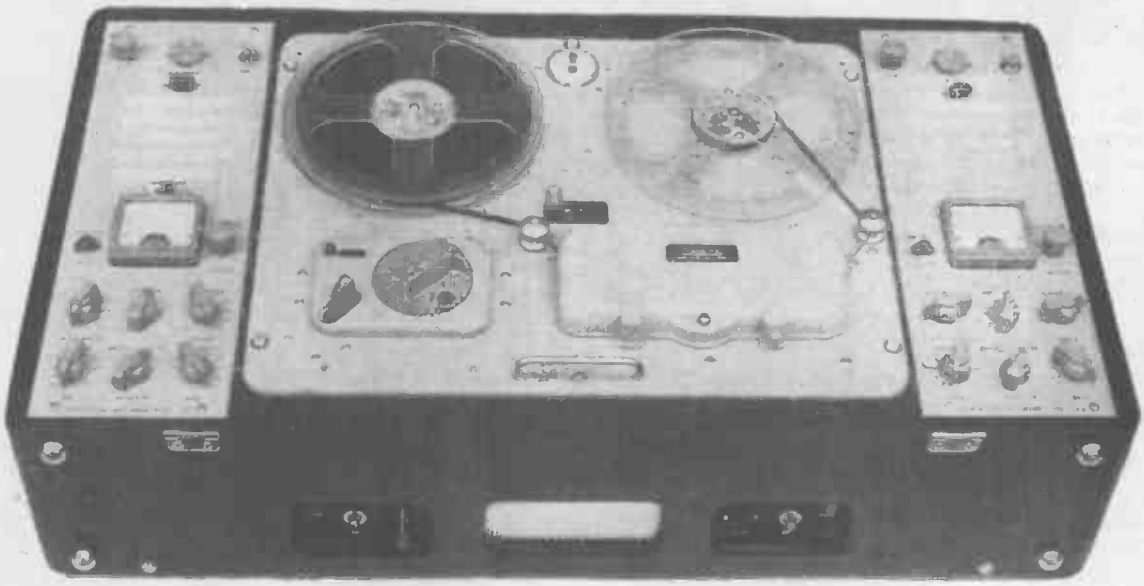
Vortexion quality equipment

TYPE C.B.L. TAPE RECORDER



Here is a versatile stereophonic recorder which has no equal in its price group.

IT CAN record monaurally or stereophonically with its own mixed inputs from Gram, Radio or other sources and from high grade low impedance balanced line microphones. With good microphones, etc. the result is a suitable master for disc manufacturers. " Before and After " monitoring is provided together with adjustable metered bias for perfection.

IT CAN also make a recording on one track and then transfer it to the other track while measuring and listening to it and adding one or two more signals also metered.

IT CAN repeat the process and transfer this combined signal to the first track with one or two more signals. Composers use it for this purpose. One track may have music or commentary and the other cueing signals or commentary and either may be altered without the other.

IT CAN playback stereophonically or monaurally with its own amplifiers of 3½ watts each.

Price £160 0s. 0d.

The Vortexion W.V.B. is a high quality monaural machine with " Before and After " monitoring. The recording inputs are a high sensitivity socket for moving coil or ribbon microphone and a high impedance socket for radio, etc. either of which can be selected by a switch. Superimposing and echo work can be done and the playback has reserve gain for abnormal requirements. This model cannot be converted for stereo playback, but it is a thoroughly reliable machine for the engineer specialising on monaural work.

Price £110 3s. 0d.

The Vortexion W.V.A. is a monaural machine which has a performance equal in sound quality to the other models. It possesses all the features of the W.V.B. except for " Before and After " monitoring, Dubbing and Echoes. The recording being made can be heard on the internal loudspeaker as in the W.V.B. and C.B.L. The controls are uncomplicated.

Price: £93 13s. 0d.

All tape recorders have adjustable bias controls, low impedance mic. inputs for unlimited lengths of cable, highly accurate position indicators and meters to measure recording level and bias.

As demonstrated at:

International Audio Festival & Fair, Hotel Russell, London, W.1.

DEMONSTRATION ROOM 204 **BOOTH 27**

VORTEXION LIMITED, 257-263 The Broadway, Wimbledon, London, S.W.19

Telephone: LIBerty 2814 and 6242-3 Telegrams: " Vortexion London S.W.19 "

SWW—111 FOR FURTHER DETAILS.

Typical mains input unit incorporating Miniature Circuit Breaker, Miniature Mains Plug and Socket (L1436) and Miniature Unitor (L1367)

in under 2 ounces

overload protection supply switching, and supply indication

In a panel space of $2\frac{1}{8}$" x $\frac{3}{4}$" you can fit this small but robust Belling-Lee Miniature Circuit Breaker. And see what it can do for your designs!

A thermal (delayed) trip for small sustained overloads —*and* magnetic coil for operation in milli-seconds where heavy fault currents occur, whilst being unaffected by harmless surges.

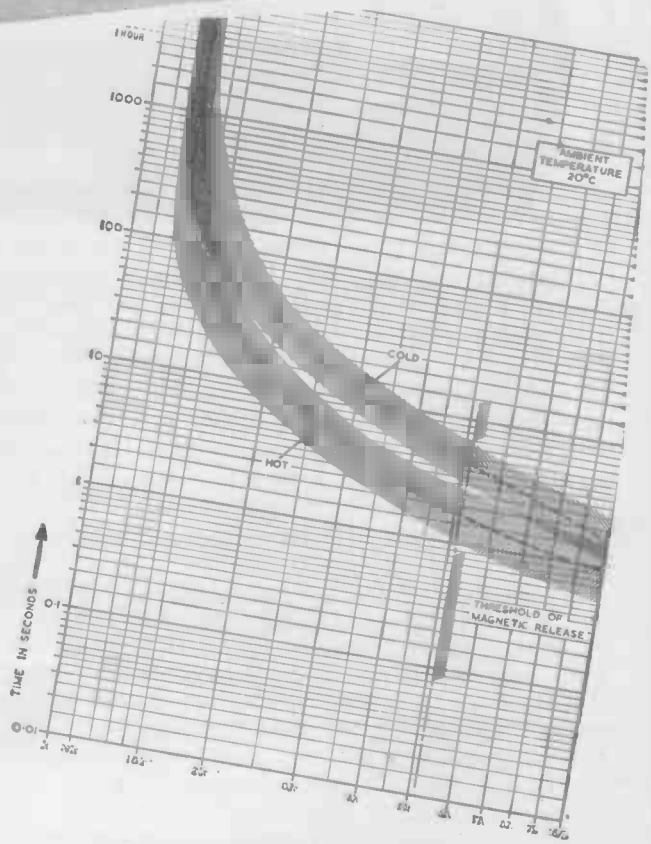
Push-button reset that gives visual indication when circuit is broken. Manual trip button that allows use as supply switch, too. Provision for special contacts for remote indicator lamp or other signalling.

Tripping time at I_R x 1.4 less than 30 minutes
I_R x 2.0 less than 60 seconds
I_R x 10.0 less than 50 milli-seconds

Rupturing capacity 750 Amp at 0.8 pf.

Tested for normal operation at −25°C to + 70°C, altitudes to 30,000 ft. Withstands accelerations of over 35g without false operation.

For full information on Belling-Lee Miniature Circuit Breakers write for section E of the Belling-Lee Technical Catalogue, which deals with this and other efficient circuit protection devices.



See Belling-Lee components at the RECMF—stand 308

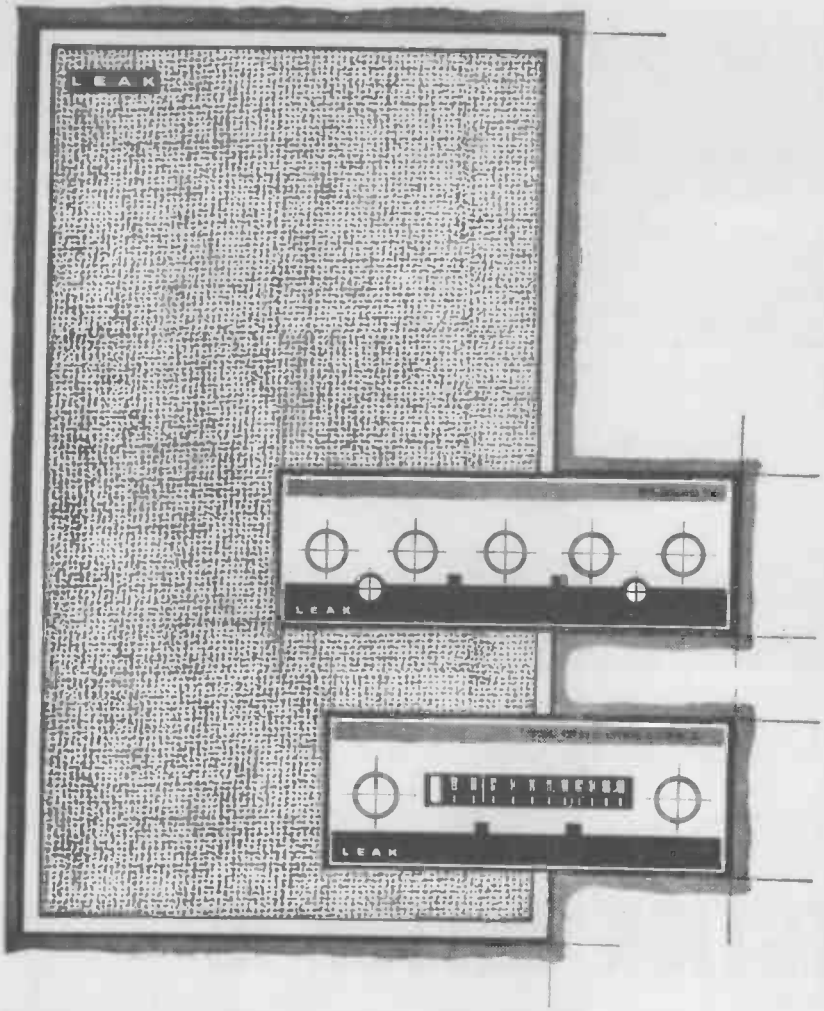
Get down to detail with

BELLING-LEE

Belling & Lee Limited · Great Cambridge Road · Enfield · Middlesex · Enfield 5393

Most Belling-Lee products are covered by patents or registered designs or applications.

5WW—112 **FOR FURTHER DETAILS.**



A MAJOR LOUDSPEAKER INVENTION THE "SANDWICH"
Price £39 : 18 : 0d.

AUDIO AND RECORD REVIEW—"*. . . This design must be regarded as a breakthrough of fundamental and far-reaching importance.*"

A SUCCESSOR TO THE FAMOUS "TROUGHLINE II":
FM "TROUGHLINE 3" Price £31 : 14 : 6d.

HI-FI NEWS—"*To sum up, the Leak Troughline II belongs to the very limited class of aristocrats in the tuner world.*"

ANOTHER MILESTONE IN AUDIO ENGINEERING "STEREO 30"
TRANSISTORISED AMPLIFIER Price £49 : 10 : 0d.

WIRELESS WORLD Editorial, May 1963—"*Last autumn during his presidential address to the British Sound Recording Association, H. J. Leak demonstrated a prototype high-quality transistor amplifier which gave results indistinguishable from those of his valve amplifiers . .*"

"*People sometimes ask why there is any necessity to change to transistors. The elimination of the output transformer is, in our view, sufficient reason now that solutions of the problem of linearity in the response of the rest of the transistor circuit have been found. As additional bonuses we get smaller size, cooler running and the prospect of longer life.*"

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first
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since 1934

If you are interested in Hi-Fi equipment combining faultless presentation with audio engineering to impeccable standards offering studio quality reproduction at reasonable cost.

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Telephone: SHEpherds Bush 1173 (PBX) Telegrams: Sinusoidal, Ealux' London

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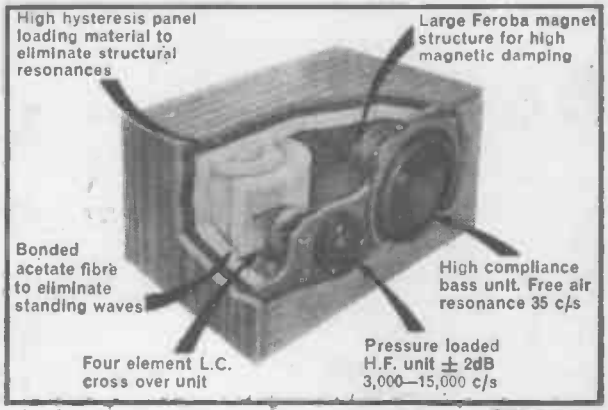
The most advanced 10 watt loudspeaker system (only ⅓ cubic ft)—

THE CELESTION 'DITTON 10'

This full range, no compromise, loudspeaker system is designed for situations where space is limited and yet the highest standards of fidelity are demanded. The 'Ditton 10' employs a new, long travel, bass unit which, combined with the Acoustic Suspension Principle, gives a low frequency distortion content unique in this size of enclosure.

PRICE £18.18.0. including tax

(Available in Walnut or Teak finishes)


High hysteresis panel loading material to eliminate structural resonances
Large Feroba magnet structure for high magnetic damping
Bonded acetate fibre to eliminate standing waves
High compliance bass unit. Free air resonance 35 c/s
Four element L.C. cross over unit
Pressure loaded H.F. unit ± 2dB 3,000—15,000 c/s

Celestion Studio Series

CELESTION LTD.

Ferry Works, Thames Ditton, Surrey.
Telephone: EMBerbrook 3402/6

CELESTION LTD. Ferry Works, Thames Ditton, Surrey.

Please send me the booklet and colour brochure on the 'Ditton 10'

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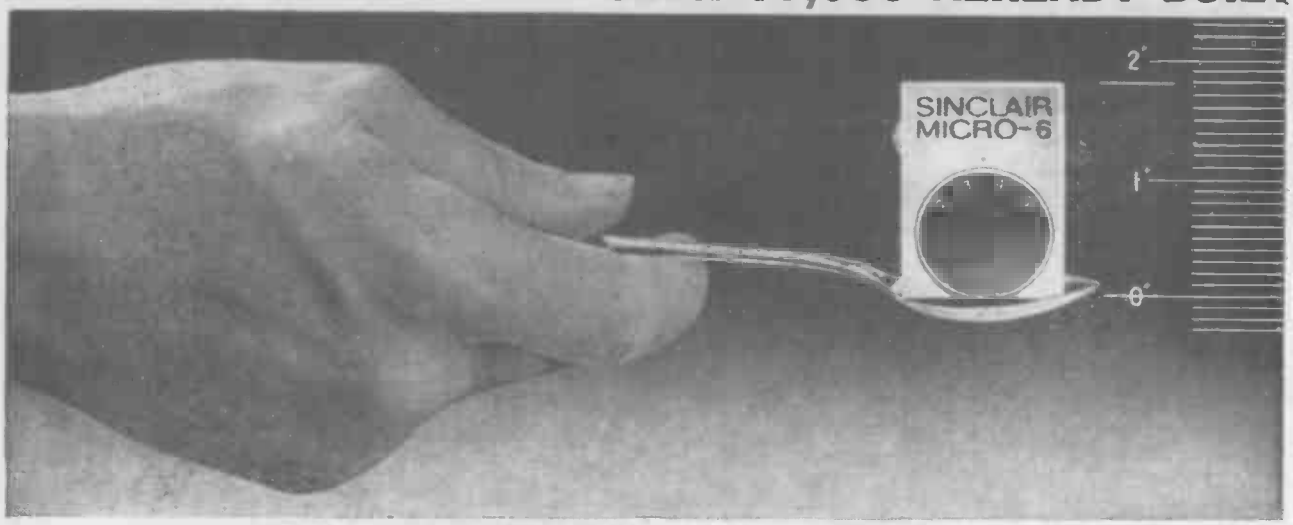
OVER 17,000 ALREADY BUILT

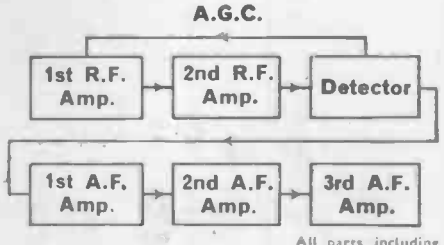


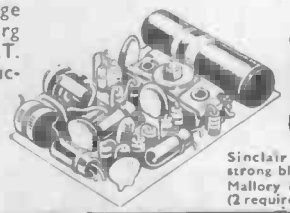
SMALLER THAN ANY SET IN THE WORLD

Fascinating to build and use

- MEASURES $1\frac{3}{5}" \times 1" \frac{3}{10} \times \frac{1}{2}"$
- WEIGHS LESS THAN 1 OZ. INC. BATTERIES
- HAS AMAZING POWER, RANGE AND SELECTIVITY
- EASILY BUILT IN AN EVENING

No set in the history of radio has ever captured the public's enthusiasm as has the now-famous Sinclair Micro-6. Never was a set so small, never so efficient and powerful. Smaller than a matchbox, the Micro-6 brings in stations from all over Europe for your pleasure and entertainment (unless you use it in the U.S.A. or Australia, for example). It performs with fantastic efficiency in cars, buses, trains as well as steel-framed buildings, yet everything to do with this set except the lightweight earpiece is contained in the minute white, gold and black case which is small enough to be held in a tea-spoon! The many attractive features of the Micro-6 include a highly stable 6-stage circuit, powerful A.G.C., bandspread for easy Luxembourg reception, vernier-type tuning and three special M.A.T. Transistors. Tunes over the medium wave-band. The instructions make building easy.





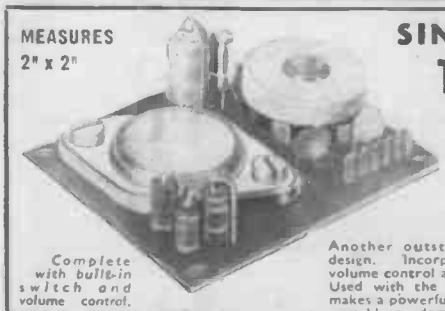
All parts including lightweight earpiece case and dial, and 8-page instructions manual come to

59/6

Sinclair "Transrista" well-styled, strong black nylon wrist strap 7/6
Mallory Mercury Cell Type ZM312 (2 required) each 1/11 Pack of 6 10/6

SINCLAIR MICRO-6

MEASURES 2" x 2"



Complete with built-in switch and volume control.

IDEAL WITH MICRO-6

All parts for building with instructions come to **39/6**

Ready built and tested **45/-**

SINCLAIR TR 750 POWER AMPLIFIER

Another outstanding Sinclair design. Incorporates its own volume control and on-off switch. Used with the Sinclair Micro-6, makes a powerful high quality car portable or domestic radio. 750 milliwatt output into a standard 25-35 ohm speaker for 10mV input. Frequency response from 30 to 20,000 c/s 1dB. The TR 750 will also make an excellent mono record reproducer (paired for stereo) baby alarm, etc.

SINCLAIR MICRO-INJECTOR

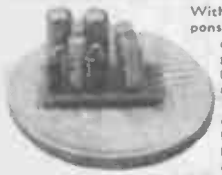
INVALUABLE IN FAULT-FINDING

This ingeniously designed device generates a test signal at any frequency from 1 Kc/s to 30 Mc/s which is injected via the probe into any part of audio or radio equipment to enable the user to trace faults rapidly and accurately. The case measures only 1.8 x 1.3 x 0.5 ins. with self-contained battery. With full instructions.

Parts for building come to **27/6**

Ready built and tested **32/6**

SINCLAIR MICRO-AMPLIFIER



With a frequency response from 30 to 50,000 c/s ±1dB and power gain of 60dB (1,000,000 times) makes a broadband R.F. amplifier, A.F. quality amplifier or F.M. Transmitter invaluable to keen experimenters.

Parts and instructions come to **28/6**

A NEW SINCLAIR AMPLIFIER

X-20

See following pages!

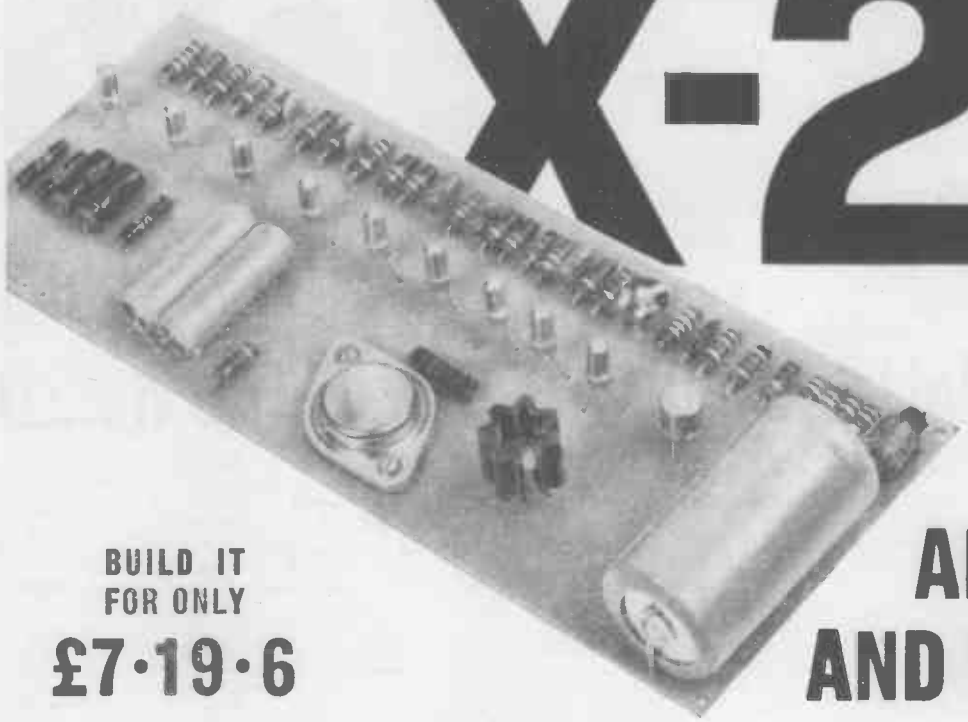
SPECIAL ORDER FORM ON THE NEXT PAGE

sinclair

SINCLAIR RADIONICS LTD
COMBERTON, CAMBRIDGE *Telephone: COMBERTON 682*

5WW—116 FOR FURTHER DETAILS.

SINCLAIR X-20



BUILD IT FOR ONLY £7·19·6

P.W.M AMPLIFIER AND PRE-AMP

New principles—New power

20 WATTS R.M.S OUTPUT!

- ★ No. of transistors—12
- ★ Output into 7.5 ohms—20 watts R.M.S. music power
  15 watts R.M.S. continuous
  Output into 15 ohms—10 watts R.M.S. continuous
- ★ Total harmonic distortion—0.1% at 10 watts R.M.S.
- ★ Frequency response—20-25,000 c/s ± 1dB
- ★ Input sensitivity—1 mV into 5K ohms
- ★ Signal to noise ratio—better than 70dB
- ★ Power requirements—36 V.d.c. at 700mA
- ★ Built-in low-pass filter in output stage

Here is proof positive of the power and quality that a Sinclair Pulse Width Modulated Amplifier can give you. The new X-20 which is complete with integrated pre-amplifier uses silicon epitaxial planars in the output stage, better than anything ever before offered in transistorised equipment for constructors. Many other refinements have been introduced into this latest Sinclair design, amongst which, for example, absolute constant amplitude is maintained in the output square wave form, irrespective of the modulation applied. Building this amplifier is exceptionally easy and the results to be obtained from it are completely rewarding. As with all quality hi-fi amplifiers, the X-20 has power and power to spare—much more in fact, than is ever required for normal domestic listening. It has superb quality too, all from a unit measuring only 8¼" × 3¼" × 1" dimensions which will inspire and enable constructors to build to entirely new concepts of design and layout.

Complete set of parts including 12 Transistors and X-20 instructions manual	£7.19.6
Ready built and tested	£9.19.6
X-20 Low-ripple mains power pack for 200/240 V.a.c. operation, sufficient for 2 X-20's	£4.19.6

sinclair

SINCLAIR RADIONICS LTD
COMBERTON, CAMBRIDGE *Phone: COMBERTON 682*

SWW—117 FOR FURTHER DETAILS.

WHAT YOU SHOULD KNOW ABOUT THIS BRILLIANT NEW SINCLAIR DESIGN

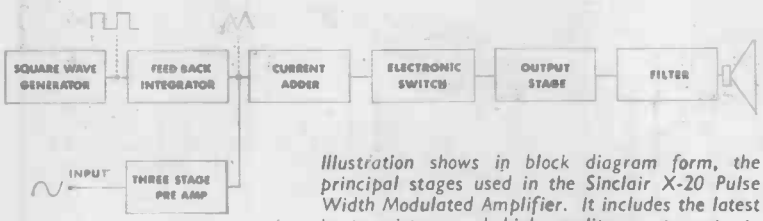
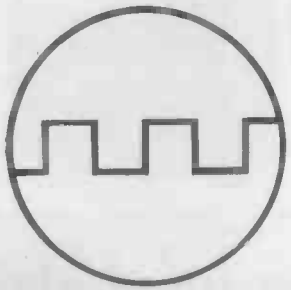


Illustration shows in block diagram form, the principal stages used in the Sinclair X-20 Pulse Width Modulated Amplifier. It includes the latest in transistors and high quality components to achieve outstanding performance.

The Sinclair X-20 integrated Pulse Width Modulated Amplifier and Pre-amp marks a further important advance by Sinclair in the development of entirely new and original amplifier designs. Many months of research and development have gone into its production and units have been subjected to impossibly severe working conditions with sensationally satisfactory results. The X-20 has even been run flat out continuously for 12 hours at 40% overload and at the end has still shown no signs of strain or distress.

CONSTANT AMPLITUDE IN ALL CONDITIONS



Pulse Width Modulation requires a perfectly formed square wave to carry the audio signal and it must be of a frequency well above the highest level of the audio spectrum. In the Sinclair X-20, the peak-to-peak amplitude of the square wave is contant at all times, no matter to what extent it is modulated by the A.F. The result is that distortion figures are lower than ever over the entire range of audio frequencies and beyond.

PULSE REPITITION FREQUENCY

In the interests of quality, the pulse repetition frequency in a P.W.M. amplifier must be as high as possible without extending into the region of radio frequencies. In the Sinclair X-20, the pulse repetition frequency is between 65 and 75 Kc/s, a value which is found to satisfy the most stringent demands likely to be made upon it in terms of uncompromising quality. This frequency is generated within the circuitry of the X-20 itself and the output has a rise-fall period of less than 0.2 micro-seconds. This is sufficient to ensure maximum efficiency in energy conversion to the loudspeaker with perfect reproduction of the audio signal itself.

OUTPUT STAGE—95% EFFICIENT

The rise and fall time of less than 0.2 micro-seconds is achieved by using silicon epitaxial planar output transistors which makes the efficiency of the output stage at least 95%. Thus only 1 watt is dissipated in each of the output transistors when the amplifier is giving an output of 20 watts. The complete linearity of the integrater and careful modulator design ensure absolutely negligible distortion right up to the maximum output.

LOW-PASS FILTER

A low-pass filter cutting off above 20 Kc/s built into the output of the X-20 ensures that the output transistors always "see" a high impedance at the P.R.F. making the amplifier widely tolerant of the type of load to which it is connected.

PRE-AMPLIFIER

This consists of three transistors with two negative feed back loops which define the gain and ensure an absolutely flat frequency response. The sensitivity is sufficient for all types of pick-ups. Provision is also made for connecting high-output devices such as P.M. Tuners.

TONE CONTROL SYSTEMS

The Manual included with the X-20 Amplifier details a variety of tone and volume control systems, any one of which may be added to the amplifier for very little outlay. Full information on stereo operation is also provided, of course.

POWER SUPPLY

A special A.C. Mains operated power supply unit is available for the X-20, delivering 36 volts D.C. Full-wave rectification is used, and the unit is supplied ready built in a completely enclosed steel case.

OTHER SPECIAL FEATURES

Because of the high energy conversion factor of the X-20, it requires no heat sink in the output stage. Connected to a 7.5 ohms loudspeaker, the power output is 20 watts R.M.S. music power. Using a 15 ohms loudspeaker, the output is 10 watts R.M.S. continuous power, a particularly useful arrangement for stereophonic hi-fi reproduction.

FULL SERVICE FACILITIES ARE ALWAYS AVAILABLE TO SINCLAIR CUSTOMERS

RUSTRAK MINIATURE RECORDERS engineered for years of rugged service

All over the world you can see Rustrak recorders mounted on the cross-arms of telegraph poles, gathering dependable data day and night, winter and summer.

Because Rustrak recorders use pressure sensitive paper they maintain optimum accuracy in temperatures from sub-zero to 160°F.; from sea level to 100,000 ft. and under conditions of high humidity.

In spite of low costs Rustrak recorders are precision instruments housed in rugged die cast aluminium cases. Motor drive mechanism, galvanometer and writing system all give years of faithful service under extremely tough conditions.

Other important features include:

NO INK. Smooth, high resolution traces are produced without ink, heated stylus or voltage sensitive paper.

11 SPEEDS WITH ONE MOTOR. With any one drive motor 11 different chart speeds are available by means of rapidly interchangeable gearboxes.

99 CHART SPEEDS. From $\frac{1}{16}$" to 450" per hour on all analogue (galvanometer) recorders.

LARGE CHART CAPACITY. At 1" per hour a standard chart roll lasts a full month.

AC, DC OR BATTERY DRIVE. Chart drive powered by AC synchronous motors of any standard voltage, DC motors which consume only milliwatts of power, or by rechargeable batteries.

RANGES. Models available to record AC and DC current and voltage and temperature.

REROLL OR TEAR-OFF. The chart is rewound inside the unit or in the tear-off type it feeds out of the recorder and may be torn off as required.

EXPERT ADVICE. Our representatives will be glad to advise you on any application.

LOW COST. Prices from £53 — portable units or for panel mounting.

Write or phone for catalogue

rustrak

WEST Instrument Limited

A Division of

GULTON INDUSTRIES (BRITAIN) LTD

The Hyde · Brighton 7 · Sussex · England

Tel: Brighton 66271 · Telex: 87171

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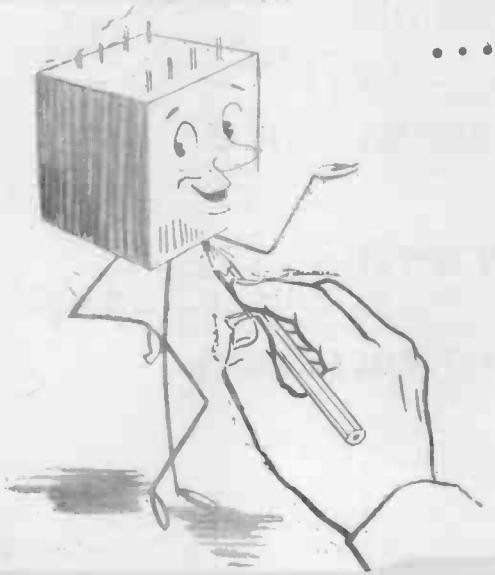


. . . but for those who use miniature transformers seriously . . .

The FERRANTI "SUBMIN" resin-cast range of transformers and chokes is becoming the automatic choice for designers of transistor circuits — not surprising when you consider the following features:

- Designed to meet all inter-service aircraft and G.W. specifications
- Superb mechanical finish
- Temperature range −55°C to +150°C
- H7 Humidity classification (DEF. 5214)

We think that our prices are reasonable and our deliveries are good. Moreover, our technical design service is second to none.

...sider our catalogue.

5 points to remember!

1. 19" Rack Panel mounted with attractive sturdy cover.
2. Two high sensitivity Mic. inputs and Gram. input.
3. All inputs independently faded and mixed.
4. Full power output at 100 V.
5. Less than 2% distortion at 10 Watts. Max output—15 Watts.

The SR 415. First in a family of P.A. amplifiers and control equipment. Each unit is mounted on a basic 19" Rack Panel and an attractive cover, as illustrated above, is available. The SR 415 is ideal for clubs, churches, youth clubs, public houses, and all forms of Public Address.

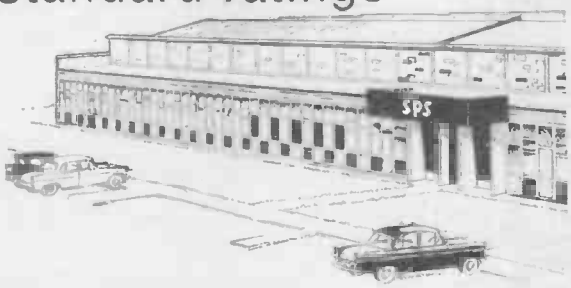
DERRITRON GROUP Reslo

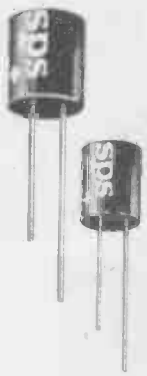
SR415 audio amplifier

RESLOSOUND LIMITED
24 UPPER BROOK STREET, LONDON, W.1. HYDE PARK 2291

5WW—121 FOR FURTHER DETAILS.

From Europe's most modern capacitor plant- Subminiature aluminium Foil capacitors in 42 standard ratings





The most modern and efficient capacitors obtainable today.

For 8 years SPS International has been producing in the U.S.A. a range of miniature lightweight capacitors designed to cope with every extreme of temperature. Now the whole benefit of this experience has been brought to the new SPS factory at Shannon, Ireland, making the same high-quality capacitors available at short notice to any part of Britain. SPS capacitors guarantee complete reliability and long life thanks to the techniques of total encapsulation perfected over a long period in the U.S.A.

Ideal for transistorized communications equipment, portable radios, hearing aids, electronic instruments, audio cross-over networks, hi-fi tuners and amplifiers, recorders, test equipment and other low voltage circuits.

CAPACITANCE—20% + 100% of rated capacity.

DISSIPATION FACTOR: Less than 8% at 50 WVDC.

D.C. Leakage: Less than 6μA after 1 min. applied WVDC.

OPERATING TEMPERATURE: 65°C at rated WVDC.

Available in 42 standard ratings, with intermediate values at no extra cost. For complete technical information and assistance write or telephone SPS International Ltd., European manufacturing arm of a leading U.S. supplier of quality capacitors.

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SPS INTERNATIONAL LIMITED
SHANNON AIRPORT, IRELAND. Tel.: Shannon 61155
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this is the MOST ADVANCED

of single decade readout counters

This single digit electromagnetic readout counter for flush panel mounting has many unique features :

Readout Signal
Available for remote indication, for predetermining or to control electric recording machines.

Decade Advance
For series operation either by through-switching of total current, or by control of relay or electronic switching of separate supply currents, amplified if necessary.

Resetting to zero
Either automatically, or at will by mechanical or electrical control.

Predetermining function
To operate at any desired digit or, in the case of series assemblies, any one or more combinations of digits.

Programmed sequences
Of functions can be arranged without difficulty.

Operation
Standard speed and voltage : 25 impulses/sec ; 24 v.d.c.; other voltages can be provided for.

Small dimensions
Main body only 4¼" deep, 1⅞" high, ½" wide; plug-in connections.

Please ask us for full technical details.

another outstanding counter from EUROPE'S MOST COMPREHENSIVE RANGE

When you think of a number—think of **HENGSTLER!**

J. HENGSTLER CO. Great Britain LTD.
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Waltham Cross 26166/7 *Broadway/JH 402*
SWW—123 FOR FURTHER DETAILS.

SHAPES OF SOUND

The Goldring-Lenco GL70

The Goldring-Lenco GL 70 transcription unit with its integrally mounted transcription arm continues to be the first choice of discriminating record lovers with custom-built equipment. Now, for those favouring the trend towards shelf/table mounted Hi-Fi units, The GL 70 is also available plinth-mounted or with shallow cabinet and clear Perspex cover.

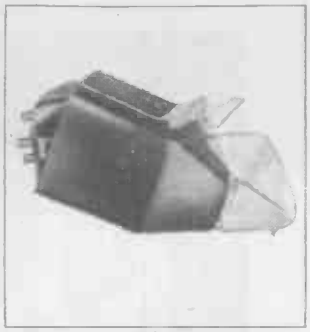
GL 70 TRANSCRIPTION UNIT. The elegant appearance of the unit is matched by its superb performance. Swiss precision engineered throughout, its silent motor drives a die-cast and machined 8 lb non-magnetic turntable through the unique conical mandrel-knife edge idler system that permits continuously variable speed adjustment from above 80 rpm to below 30 rpm and from 15 to 18 rpm. There are adjustable click-in positions of the speed control lever for the four standard speeds. The integrally mounted transcription arm (which is much in demand for use with many other motor units) has a plug-in head shell taking all standard fitting cartridges, is fully adjustable for precisely maintained stylus pressures, and is wired for both mono and stereo operation. The mains 'on/off' switch is coupled to an idler disengagement mechanism and to pick-up lowering device which facilitates groove selection and affords protection against accidental stylus-record contact.

GL 70 TRANSCRIPTION UNIT: £25.15.0 + £4.3.8 P.T.

GL 70/P unit on fabric-covered plinth: £28.15.0 + £4.13.5 P.T.

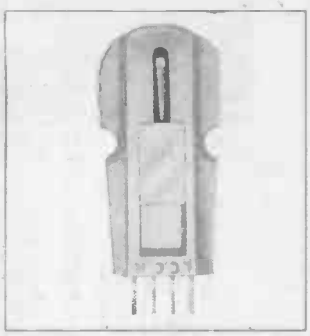
C70 CABINET AND COVER FOR GL70 Elegant sapele mahogany cabinet with removable, clear Perspex dust cover. Cut for spring or rigid mounting of unit. Size: 14″ x 17″ x 7″. **£8.19.6 + £1.12.0 P.T.**

** Recommended cartridges for GL70 are Pickering 380A Goldring CS 90 and Goldring 600.*



*** PICKERING 380A**

Moving-magnet cartridge for exceptional mono or stereo reproduction. Features the exclusive V-guard push-in diamond stylus unit which prevents damage through accidental dropping of arm on record. The Pickering 380A ensures high channel separation and virtually eliminates needle talk, hiss or distortion. Hermetically sealed, it tracks at 2 grams, faultlessly reproduces the most exacting records. £12.12.0 + £2.0.11 P.T.



*** GOLDRING CS90**

A stereo ceramic cartridge with excellent frequency response and cross-talk separation. Can be played at light tracking weights and gives an output of 50 mV. Fitted with replaceable 0.0005″ tip diamond stylus. £4.4.0 + 13.8 P.T.

*** GOLDRING 600**

Turn-over type variable reluctance mono cartridge. Fitted with diamond stylus for LP and sapphire for standard play. Exceptionally flat frequency response. A mu-metal shield eliminates the hum problems sometimes encountered when using magnetic cartridges. £8.8.0 + £1.7.4 P.T.

GOLDRING MANUFACTURING CO (GB) LTD / 486-488 HIGH ROAD LEYTONSTONE / LONDON E11 TELEPHONE: LEYTONSTONE 8343

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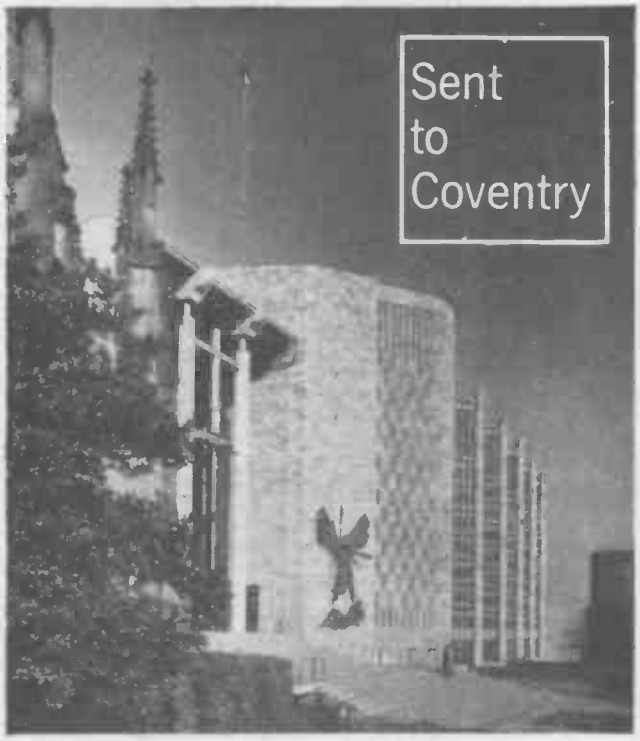

Installation by G.E.C. Illustration: Coventry Cathedral, East side. Architect: Sir Basil Spence, O.M., R.A. Photograph: Henk Snoek.

649B, the smallest dynamic lavalier microphone, was sent to Coventry Cathedral (and also to BBC and ITV studios) because of its incomparably smooth and full-bodied response; its ability to mix outputs with any standard microphone; its lack of bulk and weight; and because of its history of trouble-free operation in the USA.

This tiny handful answers studio requests for a truly miniaturised, omni-directional microphone. Its performance, whether stand mounted, or as a neck-mike, is remarkable.

Send for literature, and see for yourself.

Length: 2¼" Weight: 31 gm. Output: −61 dB

PRICE: £24

Made in the U.S.A. by Electro-Voice

Electro-Voice

Distributed in Europe by KEF

KEF

Write to: KEF Electronics Ltd., Tovil, Maidstone, Kent.
Tel: Maidstone 55761 Grams KEF Maidstone

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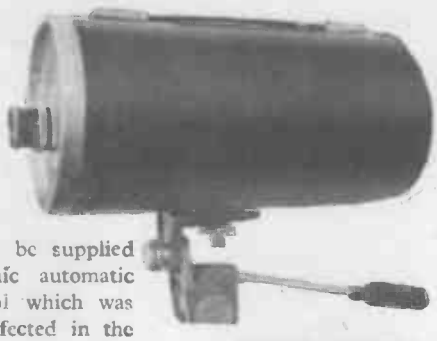
The Television Camera with 101 applications

MANUFACTURED TO A HIGH SPECIFICATION AT A REASONABLE PRICE



This camera can be supplied with an electronic automatic light level control which was designed and perfected in the Fringevision laboratories and this item can be supplied as an extra

RETAIL PRICE
£91.0.0

Send for full information

Fringevision Ltd (Electronics Division)

ELCOT LANE, MARLBOROUGH, WILTS. Telephone: 657/8

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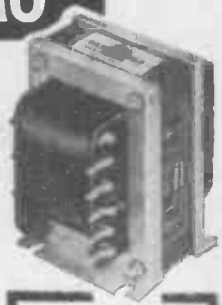
NEW Partridge TRANSFORMERS

for use with the MULLARD 10 + 10 STEREO AMPLIFIER

using ECL 86 Valves



The range of Partridge Transformers for the High Fidelity enthusiast has recently been extended by two new types, for use with the Mullard 10+10 Stereo; Output Transformer TG 1073 (price 62/6) and Mains Transformer TG 1074 (price 70/-).

ASK FOR TECHNICAL DATA SHEET No. 41

FROM STOCK AND PARTRIDGE SUPPLIERS

PARTRIDGE TRANSFORMERS LTD.

ROEBUCK ROAD, CHESSINGTON, SURREY. *Telephone: LOWer Hook 4353/4/5*

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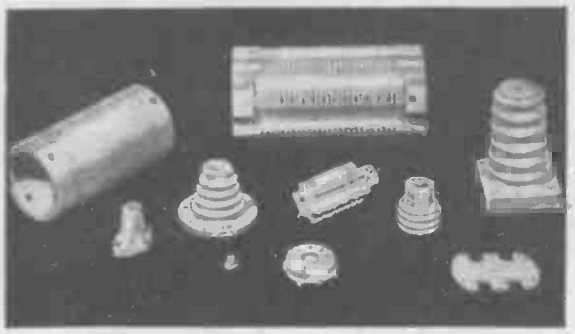
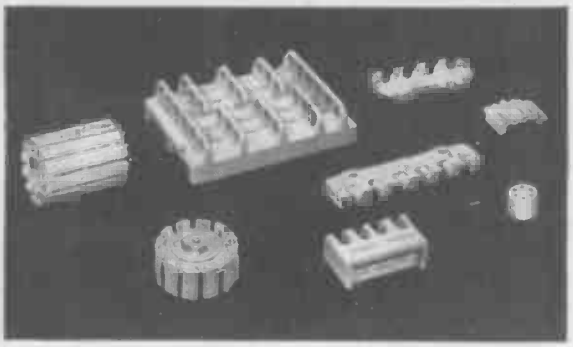
Bullers CERAMICS

for the **ELECTRONIC INDUSTRY**
(and Electrical Appliance Manufacture)



Frequelex—for high-frequency insulation.



Refractories for high-temperature insulation.

Bullers porcelain for general insulation purposes.

Meticulous care in manufacture, high quality material, with particular attention applied to *dimensional precision and accuracy*, explain the efficiency and ease of assembly when using Bullers die pressed products. *Write today for detailed particulars.*

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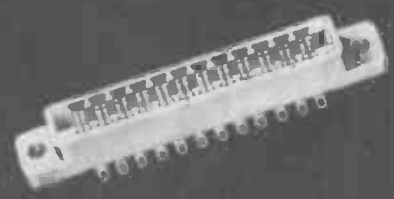
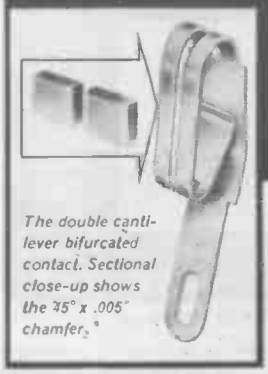
TRADE Cinch MARK

GREENLINE
moulded edge connectors





The double cantilever bifurcated contact. Sectional close-up shows the 45° x .005" chamfer.

30/2

These carefully engineered printed circuit edge connectors feature diallyl phthalate moulding for maximum insulation and special bifurcated contacts for low insertion forces, minimum wear, and positive contact at all times. Contact edges are chamfered to obviate scoring of pads and sharp radii are avoided to eliminate fatigue fractures. Available in all standard sizes from 4 to 40 ways, with gold, silver, or nickel plated contacts, and solder slot, printed circuit, or wire wrap tails. For $\frac{1}{16}$" boards with 0·150" contact pitch.

CARR FASTENER CO LTD

the firm with the best connections

Stapleford, Nottingham. Telephone: Sandiacre 2661
Sales Offices: Wembley, Sale.

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STUDENTS STROBOSCOPE

TYPE 1214A | **ESPECIALLY DESIGNED FOR THE UNIVERSITY OR SCHOOL LABORATORY**

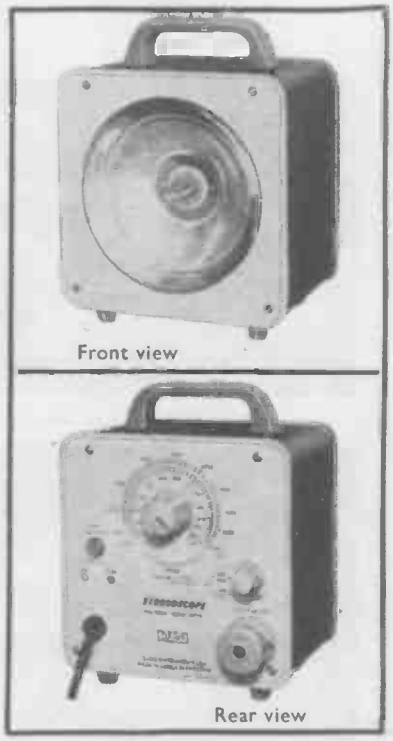
The Dawe Stroboscope Type 1214A was initially developed for the stroboscopic photography section of the Scottish Education Department's new syllabus, and is now generally available to all educational establishments.

This lightweight, portable, low cost instrument provides a stationary or slow motion image of reciprocating and rotating objects, enabling cyclic speed to be accurately measured, and distortion, vibration and resonance to be detected and studied under operational conditions. Particular applications include the study of momentum, vectors in projectile motion and free fall characteristics.

- ★ Measures directly speeds from 300 to 6,000 r.p.m.
- ★ Indirect speed measurement up to 60,000 r.p.m.
- ★ High intensity white light.
- ★ No contact with a moving part required.
- ★ Simple to operate, mains powered.
- ★ Fully portable and light in weight (approximately 6lb.).

Brief Specification

Range: Two overlapping, 300 to 1,500, and 1,200 to 6,000 flashes per minute.
Accuracy: ±5% of scale reading.
Flash Duration: 5 to 10 μS.
Mean Illumination: 80 lux at 1 metre approx.
Power Supply: 200 to 250v. 50 cycles A.C. mains.
Power Consumption: 24w.
Enclosure: Metal case fitted with carrying handle. Finished blue & grey.
Dimensions: 7¼ x 6¾ x 8¾ in. approx.



Front view

Rear view

DAWE

Full technical data from:
DAWE INSTRUMENTS LTD.,
Western Avenue, Acton, London, W.3. Tel. ACOrn 6751
A member of the Simms group of companies

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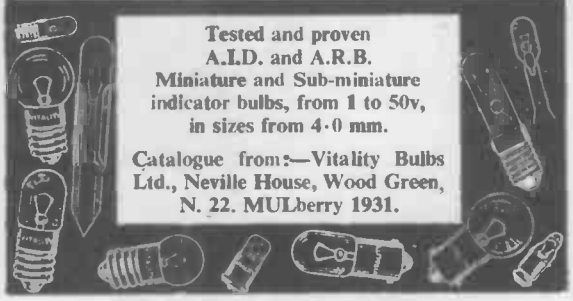
VITALITY BULBS



Tested and proven A.I.D. and A.R.B. Miniature and Sub-miniature indicator bulbs, from 1 to 50v, in sizes from 4·0 mm.

Catalogue from:—Vitality Bulbs Ltd., Neville House, Wood Green, N. 22. MULberry 1931.

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TRANSFORMERS COILS CHOKES

LARGE OR SMALL QUANTITIES
TRADE ENQUIRIES WELCOMED

SPECIALISTS IN

FINE WIRE WINDINGS

MINIATURE TRANSFORMERS
RELAY AND INSTRUMENT COILS, ETC.
VACUUM IMPREGNATION TO APPROVED STANDARDS

ELECTRO-WINDS LTD.

CONTRACTORS TO G.P.O., A.W.R.E., L.E.B., B.B.C., ETC.

123-5-7 PARCHMORE ROAD, THORNTON HEATH, SURREY
LIVINGSTONE 2261 EST. 1933

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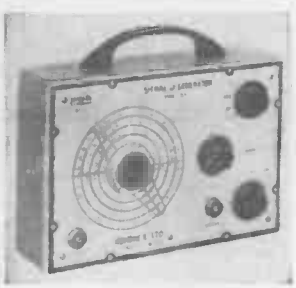

SIGNAL GENERATOR MODEL 27

NOMBREX TRANSISTORISED INSTRUMENTATION

★ Signal Generator 27	£9.15.9
★ Power Supply Unit 61	£6.13.6
★ C.R. Bridge 62	£8.10.9
★ Audio Generator 63	£17. 0.9
★ Inductance Bridge 66	£18. 5.9

All prices include battery, post and packing. Prompt Delivery.

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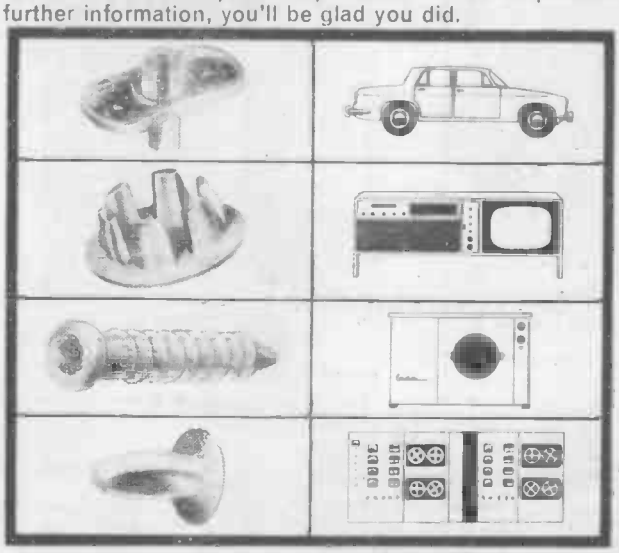

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Complete: a dia., a punch, an Allen screw and key.

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32 450 v	3/9	8+16/450 v.	3/9
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8/600 v.	9/-
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TUNING. Solid dielectric. 100pF., 300 pF., 500 pF., 3/6 each.

TRIMMERS. Compression ceramic 30, 50, 70 pF., 9d.; 100 pF., 150 pF., 1/3; 250 pF., 1/6; 600 pF., 750 pF., 1/9.

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250-0-250, 80 mA. 6.3 v. 3.5 a., or 4 v. 4 a. Rectifier 6.3 v. 1 a. or 5 v. or 4 v. 2 a.	22/6; Ditto 350-0-350, 29/6; 300-0-300 v. 120 mA., 6.3 v. CT 4 a., 0. 5. 6.3 v. 2 a.	33/6
MINIATURE 200 v. 20 mA., 6.3 v. 1 a.	10/6
MIDGET 220 v. 45 mA., 6.3 v. 2 a.	15/6
SMALL, 300-0-300 v., 70 mA., 6.3 v., 4 a.	19/6
HEATER TRANS. 6.3 v. 1½ a., 7/6; 6.3 v. 4 a.	10/6
Ditto tapped sec. 1.4 v. 2, 3, 4, 5, 6.3 v. 1½ amp.	8/6
GENERAL PURPOSE LOW VOLTAGE. Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. at 2 a.	22/6
Ditto, 1 amp., 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60	29/6
Sub-Min. Mains to 9 v. 80 mA. 1 x 1½ x 1¼in.	7/6
AUTO TRANS. 150 w., 0, 115 v., 230 v., 22/6; 500 w.	32/6

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Valves: UY85 Rectifier and UCL82 Triode/Pentode 3½ watts output. Size (inc. valves) 5 x 5½ x 2in. deep. New and Tested complete 3 ohm output tone and volume on/off controls. ONLY **37/6** P. & P. 2/6. Ready for use 200-250 v. A.C.

12in GUITAR 25w.

5GNS.

BAKERSSELHURST LOUDSPEAKERS

12in., 15 w. Stalwart 3 or 15 ohms, 45-13,000 c.p.s., 12,000 lines ..... 5 gns.

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12in. Super 20 c.p.s. to 25 kc/s ..... 16 gns.

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12in. STANDARD HEAVY DUTY 20 w. More powerful magnet 14,000 lines, special suspension, 40-14,500 c.p.s. Bass res. 40 c.p.s. **7gns.**

15in. AUDITORIUM MODEL 35 w. 17,000 lines, 20-12,000 c.p.s. Bass Res. 36 c.p.s. **18gns.**

15in. GUITAR MODEL, 50 w.

LOUDSPEAKERS P.M. 3 OHMS FAMOUS MAKES. 2½in., 3in., 4in., 5in., 7in. × 4in., 15/6 each; 8in. 17/6; 8½in. 16/6; 12in. 30/- (15 ohms 35/-); 10in. × 6in. 22/6; 8in. × 5in. 21/-; 9in. × 6in. 21/-; E.M.I. Double Cone 13½ × 8in., 45/-; Stentorian 10in. HF1012, 87/6; 8in. HF812 72/6. Crossover 3,000 c.p.s. 30/-. Horn Tweeter 104 db 2 Kc/s. to 16 Kc/s. 29/6.

WAVE-CHANGE SWITCHES WITH LONG SPINDLES. 2 p. 2-way or 2 p. 6-way or 3 p. 4-way or 1 p. 12-way 3/6; 4 p. 2-way or 4 p. 3-way, 3/6; 8 p. 4-way, 2 wafer 6/6; Wavechange "MAKITS" 1 p. 12-way, 2 p. 6-way, 3 p. 4-way, 4 p. 3-way, 6 p. 2-way. Prices include click spindles, adjustable stops, spacers, etc. 1 wafer, 8/6; 2 wafer, 12/6; 3 wafer, 16/-. TOGGLE SWITCHES, s.p., 2/-; d.p., 3/6; d.p.d.t., 4/-.

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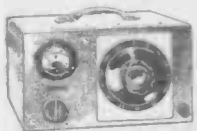
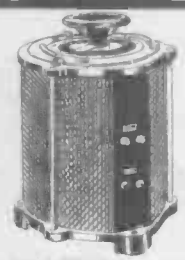


Input 230 v. A.C. Output variable 0-260 v. A.C. at 2.5 v. Fitted in beautifully finished steel case. Complete with voltmeter, pilot lamp, fuse, switch, carrying handle, £9/17/6 P.&C.5/-.



50 AMPS.

1 AMP.

INPUT 230 v. A.C. 50/60~

BRAND NEW. Carriage Paid. Buy direct from the importer, keenest prices in the country. All Types (and Spares) from ½ to 50 amp. available from stock.

0-260 v. at ½ amp.	£3	3	0
*0-260 v. at 1 amp.	£4	10	0
*0-260 v. at 2.5 amps.	£5	17	6
2.5 amps., Portable	£9	17	6
*0-260 v. at 4 amps.	£8	7	6
*0-260 v. at 5 amps.	£9	0	0
*0-260 v. at 8 amps.	£13	10	0
*0-260 v. at 10 amps.	£17	0	0
*0-260 v. at 12 amps.	£19	10	0
*0-260 v. at 20 amps.	£32	10	0
*0-260 v. at 37.5 amps.	£65	0	0
*0-260 v. at 50 amps.	£85	0	0

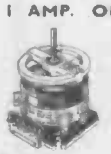
*These instruments are fully shrouded.

INSULATED TERMINALS available in black, red, white, yellow, blue and green. New, 15/- per doz. P. & P. 1/-.

7 AMP. A.C. D.C. VARIABLE OUTPUT POWER UNIT

Input 230 v. A.C. Output continuously VARIABLE from 0 to 260 v. A.C. OR 0 to 230 v. D.C. at 7 a. Robustly constructed in metal case, complete with safety fuse, neon indicator and voltmeter. Size 17 x 12 x 7in. Weight 36lb. Price £34/10/-. Carriage 20/-.

1 AMP. OPEN TYPE.



(Type 1A) Compact well constructed unit designed for building into equipment. Panel or rack mounting, extending shaft. Complete with engraved voltage panel and control knob. Input 250 v. A.C. Output variable 0-260 v. Ideally suited for Manufacturers of variable voltage equipment. Price £4/17/6 post paid.

100 WATT POWER RHEOSTATS (NEW)

Ceramic construction winding embedded in Vitreous Enamel heavy duty brush assembly designed for continuous duty.

Available in the following four values.

50 ohm. 1.4 a., 100 ohm. 1 a., 1,000 ohm., 280 mA., 1,500 ohm. 230 mA. Dia. 3½in. Shaft length ¾in., dia. ¼in., 27/6. P. & P. 1/6.

NEW ½ AMP. FULL RANGE VARIABLE VOLTAGE TRANSFORMER

Input 230 v. A.C. Output continuously variable from 0 to 260 v. at ½ amp. Size: dia. 3in., depth 3½in. including shaft, single hole fixing. Easily built into equipment. Ideal for manufacturers or Lab. use. £3/3/0.

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1 ohm., 12 amp., 17/6; 1.2 ohm, 14 amp. 27/6; 75 ohm, 2 amp. 37/6; 200 ohm, 1.25 amp. 37/6; 36 ohm, 6.5 to 2.8 amp., tapered winding, geared drive (less knob), 37/6. P. & P. 3/6.

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Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size: L. 8in., W. 4in., H. 6in. Weight 6lb. 500 volt, 500 megohms. Price £22, carriage paid. 1,000 volts, 1,000 megohms, £28, carriage paid.

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ULTRA VIOLET BULBS

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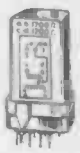
12 volt 36 watt A.C./D.C. SBC 6/6. P. & P. 1/-.
12 volt 60 watt A.C./D.C. SBC 8/6. P. & P. 1/-.
Transformer to suit the above. Input 200-240 v. A.C., 12 volt 36 watts, 16/6; P. & P. 2/6. Input 200-240 v. A.C. 12 volt 60 watt, 22/6. P. & P. 3/6.
Set of 4 Colours FLUORESCENT PAINT. Red, yellow, green and cerise. In ½ oz. tins. Ideal for use with the above Ultra Violet Bulbs. 9/6, plus 1/6 P. & P.

SIEMENS SEALED HIGH SPEED RELAYS



H96A, 2.2 ohm + 2.2 ohm., new 12/6.
H96B, 50 ohm + 50 ohm, new 12/6.
H96C, 145 ohm + 145 ohm, new 12/6.
H96D, 500 ohm + 500 ohm, new 12/6.
H96F, 1,000 + 1,000 ohm, new 12/6.
H96E, 1,700 ohm + 1,700 ohm, ex. equip., 16/6. P. & P. 1/- on each Relay.

P.O. RELAYS, Type 3,000

100 ohm 3 c/o 2 make, 2 break, 12/6
200 ohm, 6 c/o. 6,500 ohm, 1 c/o, 1 break.
500 ohm, 6 c/o. 16,000 ohm, 2 make, 2 break.
500 ohm 1 Heavy duty c/o, 12/6
500 ohm, 4 Heavy duty make.
2,000 ohm, 4 make, 4 break.
20,000 ohm, 2 Heavy duty make, 12/6
All at 12/6 each, plus 1/- P. & P.

G.E.C. SEALED RELAYS

M1069 5,000 ohm, 2 c/o. M1084 180 ohm, 4 c/o.
M1092 670 ohm, 4 c/o. M1095 670 ohm, 2 m. 2 b.
M1100 670 ohm, 2 c/o. Ex new equipment.
All at 12/6 each plus 1/- P. & P.

7,000 OHM SEALED RELAY. High Speed single c/o. Platinum contacts. Super-sensitive, ideal for Transistor circuitry. Will operate on 1 milliamp. 25/-. P. & P. 1/-.

SPECIAL REVERSING 24 VOLT D.C. MOTOR 2-AMPERE

Quadrant moves 90 degrees with limit switches. Ideal for opening doors, etc. Price 32/6 P. & P. 3/-.

SOLENOID. Overall length 3¼in., stroke ¼in. to ½in. Maximum push 8 oz. 12-24 v. D.C. operation. D.C. resistance 35 ohm. Price 8/6. P. & P. 1/6.
SOLENOID Heavy Duty 230 v. A.C. Approx. 3lb. pull. 15/-. P. & P. 1/6.
SOLENOID OPERATED MAGNETIC RELAY. Type Sc/3944, 4 Pole c/o., 10 amp. Contacts, 24 volt D.C. operation, 12/6 each. P. & P. 1/6.

SX 631 SILICON RECTIFIER. 100 v. PIV. 750 mA in air or 2 amp. on 2×2 ali. heat sink, 3/6 each, P. & P. 6d., or 4 to make bridge 12/-, P. & P. 1/-.

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Really well constructed machine. Ideal for School and Laboratory to demonstrate the various effects associated with static energy. Will work well in any atmospheric condition giving a spark over 3in. long in dry weather. 11in. dia. twin plates. 2 Leyden jars. Discharge electrodes. Heavily plated fittings, mounted on solid wooden base. Outstanding value at £13/17/6. Carriage U.K. (B.R.S.) 10/-.

RESETTABLE HIGH SPEED COUNTER. 3 figure, 1,500 ohm coil, 40-50 v. D.C. operation. Brand new, 50/- each, plus 1/6 P. & P.
EX P.O. MAGNETIC COUNTER (old type), either 500 ohms for 24 volt operation or 3 ohms for 6 volt D.C. operation. 4 figures to 9,999. Price, either type, 8/6. P. & P. 1/6.
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DIALS FOR AUTOMATIC TELEPHONES, used but good condition, 12/6 ea., plus 2/6 P. & P.

CROMPTON PARKINSON BRAND NEW ¼ h.p. MOTORS. 230/250 VOLT A.C. 1,400 R.P.M. Fitted with 2½ x ½in. SPINDLE. Price £3/5/-. Carriage 8/6.

HIGH SPEED BLOWER UNIT

200/250 volt A.C. Powerful 2-speed motor, 11,000 and 13,000 R.P.M. 17/6, plus P. & P. 2/6.
AUTO TRANSFORMERS. Step up, step down. 110-200-220-240 v. Fully shrouded. New. 300 watt type £2/6/6 each. P. & P. 2/6. 500 watt type £3/7/6 each. P. & P. 3/9. 1,000 watt type £4/10/- each. P. & P. 6/6.

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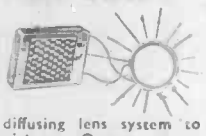
TYPE 34R SILICON SOLAR CELL



Four .5 volt units series connected in high impact polystyrene case, flying lead connections. Specially designed diffusing lens system to ensure maximum light pick-up. Output—up to 2 v. at 16—20 mA. in bright sunlight. Wider spectral response, and thirty times the efficiency of selenium cells. As used to power earth satellites! 37/6, and 1/- P. & P.

230 v. A.C. RELAY. Type 1. 2 c/o, 2 amp. contacts, 9/6. Type 2. 2×15 amp. break, 2×2 amp. make, 1×2 amp. break. 11/6. Both types ex new equip. P. & P. 1/6 each.

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Type B16G 80 r.p.m. 26lb. inch £2/2/-. P. & P. 2/-.
Type D16G 5 r.p.m. 1.7lb. inch £2/9/6. P. & P. 2/6.
Type D16G 13 r.p.m. 1.45lb. inch £2/12/6. P. & P. 2/6.

230 Volt AC 50 c/s. 5-figure Veeder-Root Counter (not resettable) New. Boxed. 19/6, plus 2/6 P. & P.

MINIATURE UNISELECTOR SWITCH

3 banks of 11 positions, plus homing bank. 40 ohm coil. 24-36 v. operation. Ex equip. individually tested. 22/6, plus 2/6 P. & P.
20-way **STRIP** containing standard Post Office telephone Jack, Sockets, overall size 11 x 3½ x 1in. New. Price 15/- each. P. & P. 1/6.

LIGHT SENSITIVE SWITCH

Kit and parts including ORP.12 Cadmium Sulphide Photocell, Relay, Transistor and Circuit. Now supplied with new Siemens High Speed Relay for 6 or 12 volt operation. Price 25/-, plus 2/6 P. & P.
ORP.12 and Circuit 8/6, post paid.

A.C. MAINS MODEL

Incorporates main transformer, rectifier and special relay with 3, 5 amp. mains c/o contacts. Price inc. circuit, 47/6, plus 2/6 P. & P.

SEMI-AUTOMATIC "BUG" SUPER SPEED MORSE KEY.
7 adjustments, precision tooled, speed adjustable 10 w.p.m. to as high as desired. Weight 2½lb. post paid.

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Latest type, twelve c/o (6 per side). Heavy duty silver contacts. Complete with chrome escutcheon plates and screws (less knob). 15/- + 1/6 P. & P.

KEYING LEVER

Especially designed for use with all types of electronic keyers. Fully adjustable micro-switch action, no contact bounce, precision made, finely polished parts. Screw down base. Price £4/4/-, post paid.
TRANSISTORISED FULLY AUTOMATIC ELECTRONIC KEYER. 230 v. A.C. or Battery operated. Incorporates built-in monitor Oscillator, Speaker, and Keying Lever. Adjustable speeds. Keying either auto., semi-auto. or hold. 4 diodes. 7 transistors. Price £16/10/-, plus 4/6 P. & P.

TRANSISTORISED MORSE OSCILLATOR Fitted 2½in. Moving Coil Speaker. Uses type PP3 or equiv. 9 v. battery. Complete with latest design Morse Key, 22/6, plus 1/6 P. & P.

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1st grade				Brand new
OC28	17/-	OC83*	6/-	2N458 20/-
OC29*	18/-	OC139	12/-	2S019 30/-
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OC72*	7/-	Get 104	6/-	AF115 10/-
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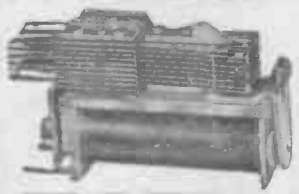

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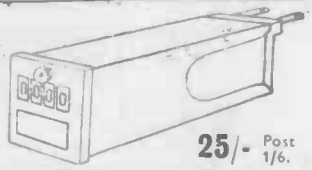

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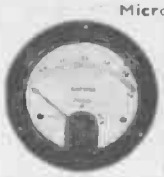

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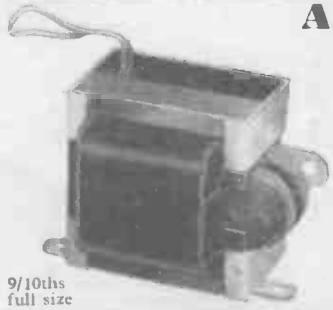

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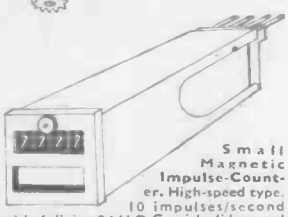

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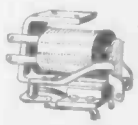

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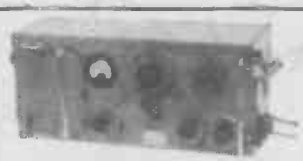

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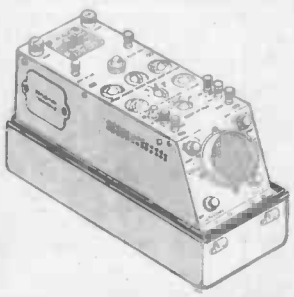
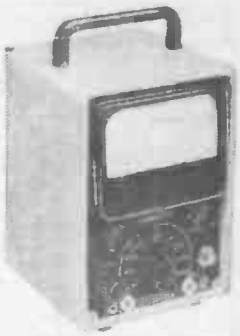
A high grade general purpose instrument made to exacting U.S.A. Navy specification. Detachable cover with carrying handle. Compact (13½ x 6 x 8½in.), weight 17 lbs. Green trace 3in. tube. Bandwidth "Y" amplifier D.C. to 2 Mc/s (D.C. coupled). Sensitivity 40 mV/cm. "X" amp. can be used separately, similar spec. to "Y" amp. Leads are housed in case. For A.C. mains 105 to 125 v., 50 to 1,000 c/s. BRAND NEW, tested and guaranteed. **£25.** Carr.10/-. *Auto transformer 15/6 extra.*



CHARLES BRITAIN (Radio) LTD.

11 UPPER SAINT MARTIN'S LANE
LONDON, W.C.2. *TEMPLE Bar 0545*
Near Leicester Sq. Station. (Opposite Thorn House)
Shop hours: 9-6 p.m. (9-1 p.m. Thursdays). Open all day Saturday.

OHM-METER



Nashton. Type V 16. A.C. mains operation 200 to 250 v. 50 c/s. 10 ohms to 1 Megohm (4 ranges) and 1 Meg to 10,000 Megs. (4 ranges). Weston 4in. mirror scale meter. Uses 4 cathode-follower valves fed from stabilised H.T. line. With circuit etc. A quality instrument at a fraction of original price. **BRAND NEW £8/19/6.** P. & P. 5/6. Details on request.

PHASE MONITOR ME-63/U (AN/URM-67)
Designed to measure directly the phase angle between two applied audio frequency signals of from 20 to 20,000 c.p.s. ±1°. Direct indication on a panel meter. Input can be sinusoidal or non-sinusoidal from 2 to 30 volts peak. Of recent manufacture (1957) by Control Electronics Inc. and ex-U.S.A. Air Force. In first class condition with handbook. A complex instrument with 19 valves. **£40.** Carr. 30/-.

MOVING COIL PHONES. Finest quality Canadian with chamois ear-muffs and leather-covered headband. With lead and jack plug. Noise excluding and supremely comfortable. **22/6.** Post 1/6. As above but complete with moving coil microphone. **25/-.** Post 2/6. DLR-5 Low impedance headphones with attached throat microphone. **12/6.** Post 1/6. All these items BRAND NEW.

T.C.C. VISCONAL CONDENSERS. 8 mfd. 800 v. D.C. wkg. at 71°C. CP 152 v. Size 3 x 1⅞ x 5in. high. BRAND NEW (boxed), 8/6 each. **DUBILIER NITROGOL.** 8 mfd. 350 v. D.C. wkg. at 71°C. Size 1⅞ x 1⅞ x 4⅞in. high. With fixing clips. BRAND NEW (boxed), 5/- each. **T.C.C.** or **DUBILIER.** 4 mfd. 600 v. wkg. CP 130T or similar. 1⅞ x 1⅞ x 4⅞in. high. BRAND NEW (boxed), 4/6 each. All post paid.

ASSORTED CAPACITORS. Mixed parcel of 100 all brand new, marked value quality types. Silver mica, ceramicon and feed through from 1 pF to 3,000 pF. **10/-.**

STANDARD TRANSFORMERS
Vacuum impregnated, interleaved, E.S. screen, universal mounting. Size 4 x 3½ x 2½in. ALL BRAND NEW. **18/6** each. Post 2/6.
Type 1. 250-0-250 v. 80 m/a. 6.3 v. 3 a. tapped at 4 v., 4 a. 6.3 v. 1 a. tapped at 4 v. and 5 v. 2 a.
Type 2. As above but 350-0-350 v. 90 m/a.
Type 3. 30 v. 2 a., tapped at 12, 15, 20 and 24 v. to give 3-4-5-6-8-9-10 v., etc.
Type 5. 0-6-9-15 v. 4 a. Ideal for chargers.

ADVANCE CONSTANT VOLTAGE TRANSFORMERS. Input 190-260 v. 50 c/s. A.C. mains. Output 230 v. 150 watts. **£7/10/-.** Carr. 5/-.

OSCILLOSCOPE TRANSFORMER
These are replacements for the Cossor 339A 'scope. BRAND NEW in original packing. Only a limited number. **79/6.** P. & P. 5/6.

SANGAMO WESTON VOLTMETERS
561. Dual range 0-5 and 0-100 v. D.C. FSD 1 m/A. 3in. scale. Recent manufacture. Ideal for schools. Complete in super quality canvas carrying case, with test prods and leads. **BRAND NEW.** Boxed **32/6.** Post 2/6.

R.S.C. (MANCHESTER) LTD.

Post Orders to R.S.C. (Manchester) Ltd. Dept. W. 54 Wellington St., Leeds, 1. Trade Supplied. Personal Shoppers to any of Branches below.

R.S.C. (MANCHESTER) LTD.

Post Terms. C.W.O. or C.O.D. No C.O.D. under £1. Postage 2/9 extra on orders under £2. 4/6 extra under £5 unless carr. stated.

R.S.C. (MANCHESTER) LTD.

BRADFORD 56 Morley Street (Half day Wed.) Now open, larger premises at 10 North Parade.

BRISTOL 14 Lower Castle St. *Tel.; 22904* (Half day Wed.)

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HULL 51 Savile St. *Tel.; 20506* (Half day Thurs.)

BRISTOL NOW OPEN

14, LOWER CASTLE STREET. (Half-day Wednesday)

HI-FI 10 WATT AMPLIFIERS

BRAND NEW Ex-Guitar Amplifiers. **£7.19.6** Carr. 4/6

A REMARKABLE OPPORTUNITY. Push-pull output. Latest high efficiency valves. Dual separately controlled inputs for mike and gram. Separate bass and treble controls. High sensitivity. Output for 3 ohm or 15 ohm loudspeaker. Guaranteed tested and in perfect working order. For 200-250 A.C. mains.

LINEAR TAPE PRE-AMPLIFIERS Type LPH. Switched equalisation. Positions for Record 1¾in., 3¾in., 7½in. and Playback. EM84 Recording Level indicator. Designed primarily as the link between Collaro Tape Transcriptor and high fidelity amplifier but suitable almost any Tape Deck. 9½ GNS. Send S.A.E. for leaflet.

TRANSISTORISED SOUND MIXER

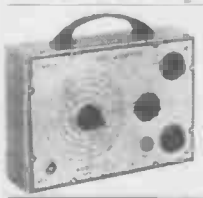
Enables mixing of up to 4 inputs, i.e. mic., tape, gram., tuner, etc., into single output. Compact and completely self-contained, uses standard 9 v. battery supplied. Four standard jack inputs.

PRICE **49/6** Post 4/6.

R.S.C. POWER PACKS 200-250 v. A.C. Completely enclosed in louvred enamelled case. 8 × 5½ × 2¼in. Output fully smoothed 250 v. 60 mA. and 6.3 v. 2 a. **39/9**

SUPERHET RADIO FEEDER UNIT

Design of a high quality Radio Tuner (specially suitable for use with any of our Amplifiers). Triode Heptode. F changer is used. Pentode I.F. and double Diode Second Detector. Delayed A.V.C. W. Ch. Sw. incorporates Gram. position. Controls are Tuning, W. Ch. and Vol. Simple alignment instructions. Only 250 v. 15 mA. H.T. and L.T. or 6.3 v. 1 amp required from amplifier. Size of unit approx. 9-6-7in. high. Send S.A.E. for illustrated leaflet. Total building cost of 5 GNS. Point-to-point wiring diagrams and instructions 2/6.



NOMBREX TEST EQUIPMENT

All transistor-portable units supplied with full instructions. 150 Kc/s. to 350 Mc/s. generator. RF Mod. AF. 8 ranges. Leads. Batteries. **£9.10.0**

Resistance/Capacitance Bridge instructions **£8.5.0**

or Credit Terms. Fully guaranteed.

STOCKISTS OF

ARMSTRONG CHASSIS

GOODMANS, W.B. and FANE SPEAKERS, LINEAR, LEAK, VERDIK, ROGERS, DULCI AMPLIFIERS, GARRARD and GOLDRING TURNTABLES.

CASH OR CREDIT TERMS

Only 3 pairs of soldered joints plus mains.

AUDIOTRINE HI-FI TAPE RECORDER KIT

Build a high quality recorder in the £70 class for only

25½ GNS. Carr. 17/6.

Can be assembled in 1 hour. Send S.A.E. for leaflet.

OR DEPOSIT £3.0.0 and 12 monthly payments of 44/- (Total 28 Gns.) Cash price if settled in 3 months.

INCORPORATING THE LATEST COLLARO STUDIO TAPE TRANSCRIPTOR THE AUDIOTRINE HIGH QUALITY TAPE AMPLIFIER, A HIGH FLUX 7 × 4in. LOUDSPEAKER Reel of Best Quality TAPE. Spare Tape Spool, a Portable Cabinet, size approx. 14½ × 15 × 8½in. finished in complementary shades of Rexine and Vynair. Connection diagram for wiring amplifier to transcriptor provided. FEATURES INCLUDE: ★ 3-SPEEDS ★ FREQUENCY RESPONSE 50-11,000 c.p.s. ★ SWITCHED NEGATIVE FEEDBACK EQUALIZING FOR EACH SPEED ★ OUTPUT 4 WATTS ★ MAGIC EYE RECORDING LEVEL INDICATOR ★ 3 MOTORS ★ Fast rewind ★ TAPE MEASURING AND CALIBRATING DEVICE ★ TAKES FULL 7in. DIAMETER REELS OF TAPE ★ NEGLIGIBLE HUM ★ ENTIRELY EFFECTIVE AUTOMATIC ERASURE.

R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1. An all-dry battery eliminator. Size 5½ × 4½ × 2in. approx. Completely replaces batteries supply 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s. is available. Suitable for all battery portable receivers requiring 1.4 v. and 90 v. Complete kit with diagram 39/9, or ready for use 49/9. Post 4/6 Type BM2. Size 8 × 5½ × 2½in. Supplies 120 v. 90 v. and 60 v. 40 mA. and 2 v. 0.4 a. to 1 amp., fully smoothed THEREBY COMPLETELY REPLACING BOTH H.T. BATTERIES AND L.T. 2 v. ACCUMULATORS when connected to A.C. mains supply 200-250 v. 50 c/s. SUITABLE FOR ALL BATTERY RECEIVERS normally using 2 v. accumulator. Complete kit with diagrams and instructions. 49/9 or ready for use 59/6. Post 4/9.

ALL INTEREST CHARGES REFUNDED

ON H.P. & CREDIT SALE ACCOUNTS SETTLED WITHIN SIX MONTHS

R.S.C. 4 WATT GRAM. AMPLIFIER KIT

Complete set of parts to build a good quality compact unit suitable for use with any record playing unit. Mains isolated chassis separate. Bass and Treble controls. Output for 2-3 ohm speaker. For 200-250 v. A.C.

59/9

R.S.C. A5 4-5 Watt HIGH GAIN QUALITY AMPLIFIER

A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 milli-volt input is required for full output so that it is suitable for use with the latest high fidelity pick-up heads in addition to all other types of pick-ups and practically all makes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum-level is negligible being 71 D.B. down. 15 D.B. negative feedback is used. H.T. of 300 v. 26 mA. and L.T. of 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit or Tape Deck pre-amplifier. For A.C. mains input of 200-250 v. 50 c/s. Output for 2-3 ohms speaker. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate) with the blue hammer finish and point-to-point wiring diagrams and instructions. Exceptional value at only £4/15/- or assembled ready for use 25/- extra, plus 3/6 carriage. Or deposit 22/- and five monthly payments of 22/- (Total £6/12/-) for assembled unit.

R.S.C. 3 WATT GRAM AMPLIFIER KIT

All parts to build a compact highly sensitive amplifier suitable for any single or autochange player. Size 12 × 2½ × 2½in. Double wound Mains transformer. For 200-250 v. A.C. mains. Output for 2-3 ohm speaker. Volume and tone control with switch. **39/9**

SELENIUM RECTIFIERS

L.T. Types	
2/6 v. ½ a. H.W.	1/9
6/12 v. ½ a. H.W.	2/9
Following F.W. (Bridge)	
6/12 v. 1 a.	3/11
6/12 v. 2 a.	6/11
6/12 v. 3½a.	9/9
6/12 v. 4 a.	12/3
6/12 v. 5 a.	14/6
6/12 v. 6 a.	15/6
6/12 v. 10 a.	25/9
6/12 v. 15 a.	35/9

R.T. Types H.W.	
120 v. 40 mA.	3/9
250 v. 50 mA.	3/11
250 v. 60 mA	4/11
250 v. 80 mA	6/11
250 v. 250 mA.	11/9
Types Below Contact cooled	
250 v. 60 mA. H.W.	5/11
250 v. 70 mA. H.W.	7/11
F.W. (Bridge) Types	
250 v. 50 mA.	8/11
250 v. 120 mA.	10/11

SPECIAL PURCHASE

BRAND NEW GARRARD 3000 LM HIGH QUALITY

STEREO/MONO AUTOCHANGE UNITS WITH LIGHTWEIGHT PICK-UP ARM AND SPECIAL HIGH FIDELITY HEAD

NORMAL PRICE APPROX. £12.15.0

LIMITED NUMBER AVAILABLE AT **10** GNS. CARR. 5/6

ACOS GP67-2G Hi-Fi Crystal Cartridges with sapphire stylus. Standard replacement for Garrard, B.S.R. and Collaro.

ONLY 16/9

Acos Stereo/Monaural 35/9

TRANSISTOR SALE

Mullard OC71 2/11. OC45, 3/11. OC44 3/11. OC72 2/11. OC81 2/11. OC171 8/9. Ediswan, XA101, XA112, XB113, XB104, XC101A. 3/9 ea. Postage 6d. for up to 3 Transistors.

JASON F.M. TUNERS

Type FMT1. All parts including Dial. Escutcheon, Punched Chassis and Valves. Power supply required 180 v. 25 mA. and 6.3 v. 1.5 a.

Type FMT1 ..... 26/19/6

Type FMT2 ..... 28/19/9

R.S.C. BATTERY CHARGERS & KITS

for 200-230-250 v. 50 c/s. A.C. Mains Guaranteed 12 mths.

HEAVY DUTY KIT

6/12 v. variable charge rate up to 6 amps. Consisting of Mains Trans. F.W. (Bridge), Selenium Rectifier, 0-7 amp. meter. Variable Charge Selector. Fuses, fuse-holders, panels, plugs and circuit. Only 59/9. Post 4/6.

TRANSFORMERS

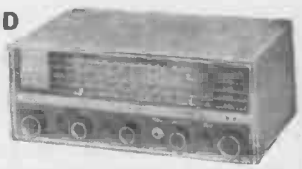
200-230-250 v. 50 c/s.	
0-9-15 v. 1½ a.	12/9
0-9-15 v. 2½ a.	14/9
0-9-15 v. 3 a.	16/9
0-9-15 v. 5 a.	19/9
0-9-15 v. 6 a.	23/9
0-9-15 v. 8 a.	28/9

BATTERY CHARGER KITS

Consisting of Mains Transformer, F.W. Bridge, Metal Rectifier, well ventilated steel case. Fuses, fuse-holders, grommets, panels, clips and circuit. Carr. 3/9 extra.

6 v. or 12 v. 1 amp.	22/9
As above with ammeter	28/9
6 v. 2 amps.	19/9
6 v. or 12 v. 4 amps	25/9
6 v. or 12 v. 2 amps (inclusive of ammeter)	35/9
6 v. or 12 v. amps. with variable charge rate selector, and ammeter	52/9

RX60 DE-LUXE 4 BAND COMMUNICATION RECEIVERS



220/240 v. 50/60 c.p.s. A.C. mains operation. Frequencies covered 1600 kc/s. to 30 Mc/s. continuous. Incorporates 5 in speaker. Slide rule tuning dial. "S" meter. Internal ferrite aerial for medium wave. Telescopic whip aerial 58in. 10 section for short waves. Fitted sockets for optional outdoor aerial. Headphones external speaker. Socket. Other features are electrical bandspread tuning. Noise limiter. A.V.C. B.F.O. stand by switch. Size approx. 12½ × 5½ × 8½in. Handsome crackle finished metal cabinet. Brand new with full instructions manual. Usual guarantee.

19 GNS. Carr. & Pack. 10/-.

FANE 122/10 20 WATT HEAVY DUTY LOUDSPEAKERS

12in. 15 ohm. With exceptionally robust 2in. diameter voice coil assembly.

5 GNS. Post Free

EX-GOVT. SELENIUM RECTIFIERS 19/9

12 v. 15 amps. F.W. (Bridge). Only

EX. GOVT. SMOOTHING CHOKES

60 mA. 10 h. 400 ohms 3/11. 100 mA. 10 h. 100 ohms. 6/9. 150 mA. 10 h. 100 ohms 10/11. 120 mA. 12 h. 100 ohms 9/9. 200 mA. 5-10 h. 100 ohms 11/9. 250 mA. 5 h. 50 ohms 10/9.

TANNOY 8 WATT RE-ENTRANT LOUDSPEAKERS. 8 ohms for workshop, factory or outdoor use 25/9 ea. Post 4/6

VALVES Full range Keen prices.

CHARGER AMMETERS 0-1½ a., 0-3a., 0-7 a. 8/9

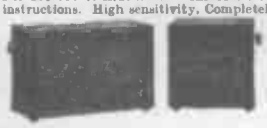
S4/4 STEREO AMPLIFIER

Complete kit of parts to construct a 4 + 4 watt good quality stereo amplifier providing realistic reproduction. Total undistorted output 8 watts. Sensitivity 180 m.v. Suitable all stereo pick-up heads. Ganged vol. and tone controls. Pre-set balance. For 200-250 v. A.C. mains only. Fully isolated chassis. Or including Stereo Head 19/9 extra. Carr. 4/6

5 GNS.

R.S.C. BABY ALARM or INTERCOM UNIT KIT

For 200-250 v. A.C. mains. Includes all parts, diagrams and instructions. High sensitivity. Completely safe. Controllable at both ends.



Housed in two cabinets of pleasing design 89/6. Carr. 5/-. Or assembled and tested 6 GNS.

5WW—141 FOR FURTHER DETAILS.

LEICESTER 32 High Street Tel.: 56420 (Half day Thurs.)

LEEDS 5-7 County (Mecca) Arcade, Briggate, Leeds 1 Tel.: 28252 (No half day)

LIVERPOOL 73 Dale Street Tel.: CENtral 3573 8 mins. from Lime St. Stn. (No half day)

LONDON 338 Edgware Rd., W.2 Tel.: PADdington 1629 (Half day Thurs.)

M'CHESTER 60a-60b Oldham St. Tel.: CENtral 2778 (No half day) New large store

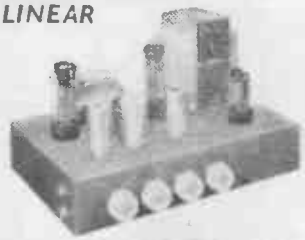
MIDDLESBROUGH 106 Newport Rd. Tel.: 47096 (Half day Wed.)

SHEFFIELD 13 Exchange Street, (Castle Market Buildings) Tel.: 20716 (Half day Thurs.)

R.S.C. (MANCHESTER) LTD.

R.S.C. A10 30 WATT AMPLIFIER

HIGH FIDELITY ULTRA LINEAR PUSH-PULL OUTPUT



SIX VALVES EF86, EF86, ECC83, 807, 807, GZ34. Tone Control Pre-Amp. stages are incorporated. Sensitivity is extremely high. Only 12 millivolt minimum input is required for full output. **THIS ENSURES THE SUITABILITY OF ANY TYPE OR MAKE OF MICROPHONE OR PICK-UP.** Separate Bass and Treble controls give both "lift" and "cut" with ample tone correction for long playing records. An extra input with associate vol. control is provided so that two separate inputs such as "mike" and gram. etc., can be simultaneously applied for mixing purposes. **AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20mA. and 6.3 v. 1.5 A. FOR A RADIO FEEDER UNIT.** Price in kit form with easy to follow wiring diagram.

ONLY 11 Gns. Carr. 10/-. Or factory built using latest EL34 output valves and with 12 months' guarantee. **14 GNS. TERMS ON ASSEMBLED UNITS, DEPOSIT 34/6** and 9 monthly payments of **33/6.** (Total 16 Gns.)

Protective Cover 19/9. Type 807 output valves are used with High Quality Sectionally Wound output transformer specially designed for Ultra Linear operation. Negative feedback of 20 D.B. in main loop. **CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE.** Frequency response ± 3.D.B. 30-20,000 c/s. Tone Controls ± 12 D.B. at 50 c/s. + 12 D.B. to − 6 D.B. at 12,000 c/s., hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish gold hammer. Overall size 12 × 9 × 9in. approx. Power consumption 150 watts. For A.C. mains 200-250 v. 50 c/s. Output for 3 and 15 ohms speakers. **EQUALLY SUITABLE FOR THE CONNOISSEUR OR FOR LARGE HALLS, CLUBS OR OUTSIDE FUNCTIONS. IDEAL FOR USE WITH MUSICAL INSTRUMENTS, SUCH AS STRING BASS, ELECTRONIC ORGAN, GUITAR, etc. FOR DANCE BANDS, GARRISON THEATRES, etc., etc. We can supply Microphone, Speakers, etc., at keen cash prices or on terms with amplifiers. EXPORT ENQUIRIES INVITED.**

R.S.C. A11 12-14 WATT AMPLIFIER

HIGH FIDELITY PUSH-PULL ULTRA LINEAR OUTPUT

"BUILT-IN" PRE-AMP STAGES

Two input sockets with associated controls allow mixing of "mike" and gram. as in A.10 High sensitivity. Includes 5 valves ECC83, ECC83, EL84, EL84, EZ81. High Quality sectionally wound output transformer specially designed for Ultra Linear operation. Reliable small condensers of current manufacture. **INDIVIDUAL CONTROLS FOR BASS AND TREBLE** "Lift" and "Cut." Frequency response. ± 3 D.B. 30-30,000 c/s. Six negative feedback loops. Hum level 60 D.B. down. **ONLY 23 millivolt INPUT required for FULL OUTPUT.** Suitable for use with all makes and types of pick-ups and mikes. Comparable with the very best designs. For **STANDARD or LONG PLAYING RECORDS.** For **MUSICAL INSTRUMENTS** such as **STRING BASS, GUITARS, etc. OUTPUT SOCKET** with plug provides 300 v. 30 mA. and 6.3 v. 1.5 a. For supply of a **RADIO FEEDER UNIT.** Size approx. 12 × 9 × 7in. For A.C. mains 200-250 v. 50 c/s. Output for 3 and 15 ohms speakers. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied (or factory built £10/19/6).

ONLY 8 Gns. Carr. 10/-. If required louvred metal covers with 2 carrying handles can be supplied for 18/9. **TERMS ON ASSEMBLED UNITS. DEPOSIT 25/- and 9 monthly payments of 25/-. (Total £12/10).** Send S.A.E. for illustrated leaflet of Cabinets, Speakers, "Mikes," etc. Cash or Terms.

R.S.C. STEREO/20 HIGH FIDELITY AMPLIFIER

Send S.A.E. for illustrated leaflet

Providing 10-14 watts Ultra Linear Push-Pull Output on each channel.

Features include:

- ★ Four-position tone compensation/selector switch.
- ★ Stereo/Mono switch so that peak monaural output of 28 watts can be obtained.
- ★ Separate bass "lift" and "cut" and treble "lift" and "cut" controls.
- ★ Neon panel indicator.
- ★ Handsome Perspex Frontplate

13 Gns. Carr. 10/- Complete set of parts with point-to-point wiring diagrams and instructions, or Factory assembled, tested and supplied with our usual 12 months' guarantee for 18 gns. or DEPOSIT 2 gns., and nine monthly payments of 41/6. Total £20/15/6.

SUITABLE for "MIKE," GRAM. RADIO OR TAPE INTENDED FOR THE HOME OR STUDIO BUT SUITABLE FOR LARGE HALLS OR CLUBS.

Based on a current Mullard design and employing valves ECC83, ECC83, ECL86, ECL86, ECL86, EZ81. Output transformers are high quality sectionally woimd to required specification. Output matchings for 3 and 15 ohm speakers on each channel. **FREQUENCY RESPONSE** ± 2db, 30-20,000 c.p.s. **HUM LEVEL**, 65dB down. **SENSITIVITY**: 15 millivolts maximum. **HARMONIC DISTORTION** (each channel) 0.2%. For operation on 200/250 v. A.C. Mains.

MANCHESTER

New large retail premises now open at 60a-60b Oldham Street.

POWER PACK KITS

Fully smoothed output 250 v. 60 mA. H.T. and L.T. 6.3 v. 1.5 amps. Consists of chassis, mains Trans. 200-250 v. Double wound, Rectifier, Choke, Electrolytics and circuit. **19/11**

FANE HIGH FIDELITY SPEAKERS

All with exceptionally robust 2in. diameter voice coil assemblies.

12in. 15 ohms. Cast chassis; HEAVY DUTY.

122/10 20 watts	5 gns.	122/10A 20 watts	6 gns.
122/12 20 watts	7 gns.	122/12A 20 watts	8 gns.
122/14 22 watts	9 gns.	122/14A 22 watts	10 gns.
122/17 25 watts	£11/17/6	122/17A 25 watts	£12/17/6

15in. 15 ohms. Cast chassis; HEAVY DUTY.

152/12 20 w.	12 gns.	152/12A 20 w.	13 gns.
152/14 27 w.	14 gns.	152/14A 27 w.	15 gns.
152/17 35 w.	16 gns.	152/17A 35 w.	17 gns.

"A" indicates dual cone type 30-17,000 c.p.s. Send S.A.E. for leaflets. Terms available.

R.S.C. TRANSFORMERS

FULLY GUARANTEED

INTERLEAVED and IMPREGNATED

MAINS TRANSFORMERS. Primaries 200-250 v. 50 c/s.

FULLY SHROUDED. UPRIGHT MOUNTING.

250-0-250 v. 60 mA., 6.3 v. 2 a. 0-5-6.3 v. 2 a. 2½-3-3in.	18/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a.	29/9
300-0-300 v. 100 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a.	29/9
300-0-300 v. 130 mA., 6.3 v. 4 a. c.t., 6.3 v. 1 a. For Mullard 510 Amplifier	36/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a.	29/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a.	38/9
425-0-425 v. 200 mA., 6.3 v. 4 a., c.t., 5 v. 3 a.	59/9
425-0-425 v. 200 mA., 6.3 v. 4 a., 6.3 v. 4 a., 5 v. 3 a.	63/9
450-0-450 v. 250 mA., 6.3 v. 4 a., c.t. 5 v. 3 a.	69/9

TOP SHROUDED DROP-THROUGH TYPE

250-0-250 v. 70 mA., 6.3 v. 2 a., 0-5-6.3 v. 2 a.	17/9
250-0-250 v. 100 mA., 6.3 v. 3.5 a.	19/9
250-0-250 v. 100 mA., 6.3 v. 2 a., 6.3 v. 1 a.	21/9
350-0-350 v. 80 mA., 6.3 v. 2 a., 0-5-6.3 v. 2 a.	21/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a.	28/9
300-0-300 v. 100 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a.	28/9
300-0-300 v. 130 mA., 6.3 v. 4 a., 0-5-6.3 v. 1 a. suitable for Mullard 510 Amplifier	35/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a.	28/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a.	37/9

MIDGET CLAMPED TYPE. Primaries 200-250 v.

250-0-250 v. 60 mA., 6.3 v. 2 a., 2 × 2 × 2¼in.	13/9
250 v. 60 mA., 6.3 v. 2 a. Size 2 × 2 × 2¼in.	12/9

FILAMENT TRANSFORMERS 12 v. 1 a. 7/9

6.3 v. 1.5 a.	5/9	6.3 v. 3 a.	8/11
6.3 v. 2 a.	7/6	6.3 v. 6 a.	17/9
		12 v. 3 a. or 24 v. 1.5 a.	17/9

AUTO (Step UP/Step DOWN) TRANSFORMERS

50-80 watts 110-120 v./230-250 v.	14/9
150 watts 110-120 v./200-250 v.	27/9
250 watts 110-120 v./200-250 v.	49/9

OUTPUT TRANSFORMERS

Midget Battery Pentode 66.1 for 3S4, etc.	4/6
Small Pentode 5,000Ω to 3Ω	4/6
Standard Pentode 5,000Ω to 3Ω	5/9
Standard Pentode 7,000Ω to 3Ω	5/9
Push pull 8 watts EL84 to 3Ω or 15Ω	8/9
Push pull 10-12 watts 6V6 to 3Ω or 15Ω	18/9
Push pull 10-12 watts to match 6V6 to 3-5-8 or 15Ω	19/9
Push pull EL84 to 3 or 15Ω 10-12 watts	18/9
Push pull Ultra Linear for Mullard 510, etc.	29/6
Push pull 15-18 watts, sectionally wound 6L6, KT66, etc., for 3 or 15Ω	29/9
Push pull 20 watt high-quality sectionally wound, EL34, 6L6, KT66, etc., to 3 or 15Ω fully shrouded	49/9

MICROPHONE TRANSFORMERS

120-1 High quality, clamped	8/9

SMOOTHING CHOKES

250mA., 5 H., 100Ω	11/9	80 mA., 10 H., 350Ω	5/6
150mA., 7-10H, 250Ω	11/9	60 mA., 10 H. 400Ω	4/11
100mA., 10 H., 200Ω	8/9	1 amp. 0.5Ω L.T. type	6/6

R.S.C. STEREO 10 HIGH QUALITY AMPLIFIER

Complete kit of parts including Valves EZ81, ECC83, ECC83, EL84, EL84. Separate bass and treble controls giving "cut" and "boost" Sensitivity 50 mV. 5 watts high quality output on each channel. Can be used as straight 10 watt amplifier. Controls: Stereo/Monaural switch ganged volume, ganged treble, ganged bass and balance. Output for 3 ohms speaker. Point-to-Point wiring diagrams and instructions. Illustration full wiring details and priced parts list 1/9. Or supplied assembled and tested 59/6 extra.

8 GNS. CARR. 8/9.

Deposit 42/- and nine monthly payments of 24 2 (Total £12/19/6)

LOUDSPEAKERS IN CABINETS. 12in. 10 WATT. Walnut Veneered Cabinet size 15 × 15 × 8in. approx. High quality 12in. 10 watt 12,000 line speaker 3 ohms or 15 ohms **£4/19/6.** Carr. 5/-. Or Deposit 11/3 and nine monthly payments **11/3. (Total £5/12/6).** 12in. **20 WATT.** High Quality 15,000 line 1/speaker 15 ohms in Cabinet finished as above. Size 18 × 18 × 8in. **£7/19/6.** Carr. 7/9. Or Deposit 17/9 and 9 monthly payments of **17/9.** (Total £8.17.6).

AUDIOTRINE HIGH FIDELITY SPEAKER SYSTEMS

Designed to provide a smooth frequency response from 40-20,000 c.p.s. consisting of 12in. 12,000 line 15 ohm speaker. Crossover Unit and Tweeter. Highly recommended for use with any High Fidelity Amplifier. 10 Watt Unit. **£4/19/6** Carr. 5/6 or Deposit 11/3 and nine monthly payments of 11/3. (Total £5/12/6). 20 Watt Unit **£6/19/9** Carr. 7/6 or Deposit 15/8 and nine monthly payments of 15/9. (Total £7/17/6)

GL3A MINIATURE 3-WATT GRAM. AMPLIFIERS. For 200-250 v. 50 c.p.s. A.C. mains. Overall size only 11½ × 2½ × 2¼in. Fitted Vol. and Tone Control with mains switch. Designed for use with any kind of single player or record changer unit. Output for 2-3 ohm speaker. Only **59/6**

COLUMN SPEAKERS

For Public Address systems, vocalists etc., 15 ohms, or 330 ohms for 100 v. line.

TYPE C58

Rating 15-20 watts. Fitted five 8in. high flux speakers. Size approx. 42 × 10 **12½ Gns.** × 5in. Carr. 10/-.

Or Deposit 29/- and 9 monthly payments of 29/-. (Total £14.10.0).

100 v. line version 35/- extra.

TYPE C412

Rating 40 watts. Fitted four 12in. high flux (12,000 lines) speakers. Cabinets finished two-tone Rexine/Vynair. Size approx. 54 × 14 × 8in. Carr. 15/-.

Cash **19½ Gns.**

Or Deposit 51/9 and 9 monthly payments 44/5. (Total 21½ Gns.).

R.S.C. STANDARD BASS REFLEX CABINET. For 12in. Loudspeakers, Acoustically lined and ported. Size 20in. × 14in. × 18in. Beautiful walnut veneer finish. Especially recommended for use with Audiotrine Speaker System. **£5/19/6.** Carr. 5/6. Set of four legs can be supplied with brass ferrules for 19/6.

AUDIOTRINE CORNER CONSOLE CABINETS. Strongly made. Beautiful polished walnut veneered finish. Pleasing design.

JUNIOR MODEL. To take up to 8in. speaker. Size approx. 20in. × 11in. × 8in. Only 49/9.

STANDARD MODEL. To take up to 10in. speaker. Size 27in. × 18in. × 18in. **£5/10/-** Carr. 7/6.

SENIOR MODELS. To take up to 12in. speaker and with Tweeter cut-out. Size approx. 30in. × 15in. × 15in. (Recommended for use with Audiotrine speaker system.) 8 Gns. Carr. 7/6 or terms.

W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS HF1012. 10 watts rating. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance. **£4/12/-.** Please state whether 3 ohm or 15 ohm required.

R.S.C. JUNIOR BASS REFLEX CABINET. Designed for above speaker, but suitable for any good quality 8in. or 10in. speaker. Acoustically lined and ported. Polished walnut veneer finish. Size 18in. × 12in. × 10in. Strongly made. Handsome appearance. Ensures superb reproduction for only **£4.10.0.** Deposit 10/9 and 9 monthly payments of 10/9 (Total £5/7/6.)

IMMEDIATE DELIVERY

ALL ITEMS FULLY GUARANTEED

AC/DC VALVE VOLTMETER

Latest circuitry provides perfect stability and sensitivity.

Professionally acknowledged.

Just Look at this specification!

★11 megohms per volt.
★5mV-1,500 V. A.C.
★100 mV-1,500 V. D.C.
★0.1 ohm—1,000 Megohms.

PLUS

★1 Kc Oscillator Test Source
★Complete with Test Probe with BUILT-IN A.C./D.C. switch, no fumbling or fiddling with out of reach knobs.

This superbly finished instrument is invaluable in Production depts. and Labs. and is presented in an attractive light grey crackle steel case with satin alloy front.
Mains operated.
Size and weight: 5½in. × 3in. × 8in. high. 5½lb.

Price ONLY **£35.0.0**

—no extras.

VARIABLE VOLTAGE TRANSFORMERS

World famous "SLIDUP"

★ *RATED CURRENT CONSISTENT AT ALL POINTS ALONG THE WINDING.*

Output: 0-260 v. Input: 230 v. A.C. 50/60~.

Shrouded fully variable transformers for bench or panel mounting.

2·5 Amp.	£5.17.6
5 Amp.	£9. 0.0
10 Amp.	£18. 5.0
20 Amp.	£32.10.0

Ex. works. Carr. & Pkg. EXTRA

Model SB10 10 amp.

Inset shows latest type brush gear providing 1 volt variation.

CONSTANT VOLTAGE TRANSFORMER

AUTOMATIC MAINS STABILIZER

Modern design in 2-tone hammer steel case with handle. Complete with lead and plug.

Provides perfectly stabilized constant voltage for all laboratory equipment.

★ No Moving Parts ★ No Maintenance. ★ No Attention.

SPEC: Input: 240 v. A.C. ± 20%
Output: 240 v. A.C. 50 cycles.
Capacity: 1 AMP.
Accuracy: ± 1%.
Size: 11 × 6½ × 3½.

Weight 21 lbs. Fitted signal lamp and switch.

£11.10.0 Carr. & Pkg. 20/-

Complete with lead and plug, in attractive silver hammer metal case with handle.

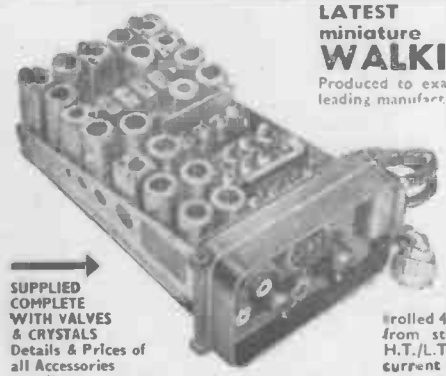
PORTABLE VARIABLE A.C. POWER SUPPLY UNIT

DESIGNED FOR ENGINEERS WHOSE REQUIREMENTS CALL FOR A VISUAL INDICATION OF VOLTS APPLIED.

OUTPUT: 0-260 v. 1½ amps.

INPUT: 230 v. A.C. 50/60~. Unit fitted with fuse, voltmeter, safety indicator, on-off switch and lead. Size: 8 × 5 × 5 in. high

PRICE **£8.10.0** Carr. & Pkg. 10/-



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Produced to exacting specifications by leading manufacturers E. K. Cole & Co.

Only **£10.0.0** EACH

This Transmitter /Receiver weighs only 5½lb.(appx.) and measures 3½ × 5½ × 9½in. A crystal controlled 4 frequency set operates from standard dry battery—H.T./L.T. (i.e. Vidor L5537). 14 current series B7G valves used.

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Details & Prices of all Accessories supplied on request.

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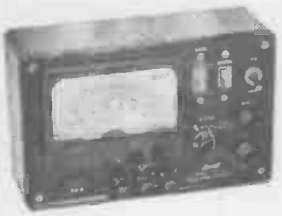

Model AT—1 **£10.10.0** Carr. & Pkg. 7/6

FULLY PORTABLE PRECISION INSTRUMENT

MEASUREMENT RANGES

Ico (Icbo) and the reverse current of diodes.

PNP & NPN—0~50uA (1μA per scale).

POWER—0~mA (20μA per scale). β5-200 (5 per scale).

Bias Current—
(1mA on PNP & NPN)
(5mA on POWER)

α0.9-0.995 (from $\beta = \frac{\alpha}{1-\alpha}$)

Terminals: Spring Sockets and Screw Terminals.

Meter: 4in. 50μA moving coil.

Size and Weight: 7 × 5 × 3in.-2¼lb.

Powered by pen cells.

VARIABLE HIGH-VOLTAGE UNIT

DIELECTRIC BREAKDOWN TESTER

★ Range: Infinitely variable up to 3,000 volts and can be accurately set, 0.1 amp.

★ Entirely suitable for continuous testing.

★ Built-in Automatic safety cut-out.

Input: Mains voltage.
Robustly constructed for bench use with 4½in. × 4in. modern styled meter, placed at an easy to read angle.

Complete with input and test leads with clips.

Model T30, 0-3,000 v. A.C. £32.

TRANSISTORISED MEGOHMMETER

★ NO WINDING!
★ PUSH BUTTON TO READ

500V.-1,000 MEGOHMS

Portable, supplied c/w batteries, probes and carrying case. Superb instrument.

ONLY **£23.10.0** Carr. & Pkg. 7/6

Also: 500 v.-500 Megohms mains operated insulation tester. Designed for continuous use. £26-5-0.

LATEST DESIGN!

20 AMP. 12/24 Volt D.C. HEAVY DUTY SUPPLY UNIT

Spect Output. Adjustable up to 20 amps continuous at 12/24 volts plus trickle. Input. 220/230/240 VAC .50 cycles. Input & Output fully fused, Neon indicator, 0-20 amp meter. Size: 16" × 12" × 20" high, in heavy gauge steel cabinet, Grey Hammer finish. Weight: 50 lbs.

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LONDON'S LARGEST SUPPLIERS OF ELECTRONIC EQUIPMENT
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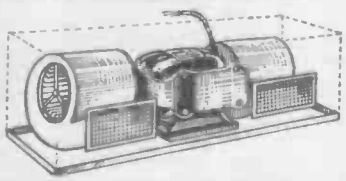
BLOCK CAPACITORS
NEW AND GUARANTEED

Maker	Mfd.	DCV wkg.	Temp.	Price	Carr.
T.C.C.	8	1,500	60°C	17/6	2/6
T.C.C.	8	1,000	60°C	10/6	2/–
G.E.C.	8	600	60°C	7/6	2/–
T.C.C.	8	250	70°C	8/6	1/6
Dubilier	8	1,000	60°C	9/6	2/–
Dubilier	8	750	60°C	9/6	2/–
U.S.A.	7	600	100°C	6/6	1/6
U.S.A.	5	220	100°C	3/6	1/6
T.C.C.	4	2,000	60°C	17/6	2/6
T.C.C.	4	1,000	60°C	3/6	1/–
T.C.C.	4	400	70°C	3/6	1/–
BI	4	800	70°C	5/6	1/6
Dubilier	2	5,000	70°C	35/–	3/6
Dubilier	2	2,500	70°C	17/6	2/6
T.C.C.	2	1,000	60°C	5/–	1/–
T.C.C.	2	500	60°C	2/6	1/6
T.C.C.	1.5	4,000	60°C	12/6	2/6
T.C.C.	1	7,500	70°C	50/–	5/–
T.C.C.	1	2,500	60°C	17/6	3/6
T.C.C.	1	600	70°C	2/6	1/–
Dubilier	1	5,000	70°C	30/–	3/–
T.C.C.	0.5	500	60°C	2/–	1/–
Dubilier	0.5	5,000	70°C	17/6	2/6
Dubilier	0.5	2,000	70°C	8/6	2/–
Dubilier	0.25	5,000	70°C	12/6	3/–
Dubilier	0.25	7,500	70°C	17/6	3/–
T.C.C.	0.25	5,000	60°C	12/6	3/–
B.I.C.	0.1	5,000	60°C	10/6	3/–

TWIN TURBO BLOWERS



A.C. 200-240 volts ¼ h.p. motor 2,850 r.p.m. Manufactured by famous manufacturers for computer equipment in perfect condition. Completely enclosed size 24 x 8 x 8in. £7/19/6. carr. 7/6.

1% RESISTANCE BOXES FOUR DECADES

1.10-100Ω. 2.100-1,000Ω. 3.1K-10KΩ 4.10K-100kΩ. **High Stability Resistors** arranged as a potentiometer, rated at 1 watt at 70 deg. C. and 1½ watts at 42 deg. C. Tolerance plus or minus 1%. Specially designed for use in technical colleges and schools where a high-precision instrument is required at low cost. Supplied brand new and guaranteed. £9/19/6. P.P. 3/6.

STC INTER-COM. TELEPHONES. Latest type. All components, Buzzer and Battery housed in beautifully made Hand Set. Size 9 x 2½ x 2½in. Effective communication up to 60 miles. Supplied brand new, £9/12/– per pair. P.P. 4/–. Further particulars sent on request.

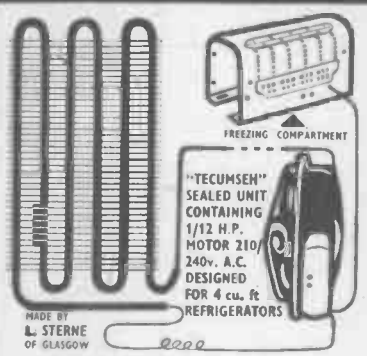
G.P.O. HIGH SPEED COUNTERS

Latest Design Type 1000 4.1Ω 316 v. D.C. Type 100 a. 500Ω 18.24 v. D.C. either type 15/–. P.P. 1/6.

PHILIPS AUTO TRANSFORMERS. Ideal for mains boosting. Tapped 220, 230, 240, 250 volts. 600 watts. Terminal block connections. Brand new, 39/6. Carr. 6/–.

MAGNETIC DEVICES SOLENOIDS. 180 v. D.C. Overall size 1¼x1¼x1¼ in. Approx. ½ in. pull. 5/- ea. P.P. 1/6. 48/- doz. P.P. 5/–. Also available for 50 v. operation. 7/6. P.P. 1/6.

REFRIGERATION SEALED UNITS
BRAND NEW!


FREEZING COMPARTMENT
"TECUMSEH" SEALED UNIT CONTAINING 1/12 H.P. MOTOR 210/240v. A.C. DESIGNED FOR 4 cu. ft REFRIGERATORS
MADE BY L. STERNE OF GLASGOW

Freezer 12 x 6½ x 5ins. Sealed unit 9 x 9 x 5Ins. Condenser 12 x 20ins. Ideal for replacement units, refrigeration and cold cupboards and stores. In original packing **£8-10-0** P. & P. 10/-.
THERMOSTATIC CONTROL 15/- P.P, 1/6 sold separately.

BRAND NEW 30 AMP. VENNER TIME SWITCH Type MD 1 BP.
Size 5½ x 8 x 4½in. deep. 24 hr. dial. One on, one off. Beautifully finished in black bakelite case with perspex window. Packed in original cartons at fraction of maker's price. P.P. 5/–

£3-19-6
Arms for extra switch 6/– per pair

L.T. SUPPLY UNIT TYPE S.E.1

A.C. input 200-240 v. D.C. Output tapped to give 12 or 24 volts 8 amps. continuous rating. Fitted with panel fuse. Mains on/off switch and D.C. output socket. Built in strong metal case. Size 15 x 6 x 6in. An ideal general purpose L.T. supply unit for operating relays. Contactors, battery charging, etc. £9/19/6, carr. 7/6.

L.T. SUPPLY UNIT TYPE S.E.2

A.C. input 200-240 v. D.C. output 50 volts 5 amps. Built-in metal case size 15 x 6 x 6in. Fitted with on/off switch, panel fuse, and output socket, £9/19/6, carr. 7/6.

SIEMENS MINIATURE SELECTOR SWITCHES

Latest plug in type. 10 way 3 bank 3 wiper, type 2,200 c. 50 Ω. Size 3½ x 2½ x 1½in. complete with base. Fraction of makers Price 69/6, P.P. 2/6.

GRESSALL HEAVY DUTY RHEOSTATS

26 ohms 4 amps, 6in. dia., carbon track, Panel mounting. Length of spindle 1½in., ¼in. dia. **BRAND NEW 45/–.** carr. 4/–.

MAGNETIC DEVICES MINIATURE RELAYS 2000Ω 2 C.O. contacts size 1x¾x¾in. 10/6 P.P. 1/-

HEAVY DUTY SLIDER RESISTORS Zenith Double Tube Geared Drive Log Wound. 1.3Ω 15 amps. Continuing to 55Ω 2 amps. Overall size: 22 x 9½ x 7½in. £3/19/6, carr. 7/6. 4Ω 8 amps. Single Tube enclosed, 32/6, P.P. 4/–. 30Ω 1.25 amps. 5 Tube Gear Drive, 25/–, P.P. 3/–. 1Ω 12 amps., 12/6, P.P. 2/6. Ganged Twin Rheostats, 6in. dia. 200Ω 1.2 amps. each. Complete with Fixing Frame and Control Knob, 75/–, carr. 0.4Ω 25 amps. fixed with adjustable clip 15/- P.P. 2/6

MULTI TAPPED L.T. TRANSFORMERS
All Primaries 220-240 v.

Type	Sec. Taps.	Amps.	Price	Carr.
A 3, 6, 9, 10, 12, 15, 20, 24, 30 v.		2	25/–	4/–
B	Ditto	4	39/6	4/6
C	Ditto	5	45/–	5/–
D	Ditto	8	59/6	7/–
E 6, 8, 10, 15, 19, 25, 33, 40, 50 v.		3	45/–	5/-
F	Ditto	6	87/6	7/6
G 12, 15, 20, 24, 30 v.		10	69/6	7/6
H 6, 9, 15 v.		4	22/6	4/–
I	Ditto	1½	15/–	2/6

AUTO TRANSFORMERS

240-110 v. completely shrouded fitted with 2 two pin American sockets or terminal blocks. Please state which type required. 1,000 watts £4/15/-, carr. 5/-. 500 watts, carr. 4/-. 300 watts 47/6, carr. 3/6. 150 watts 37/6, carr. 3/-. 60 watts 29/6, carr. 2/6.
2,000 watts completely enclosed in metal case, size 10 x 8 x 6in. Fitted with 2 American two-pin sockets or terminal blocks £9/15/-, carr. 7/6.

A.C. VARIABLE SUPPLY UNITS

Input 230 v. A.C. output variable 0-260 v. A.C. Fitted in steel case, complete with v/meter, pilot lamp, fuse, switch, carrying handle.
1½ amps. output £8/10/-, carr. 7/6.
2½ amps. output £9/17/6, carr. 7/6.

SPECIAL OFFER OF PARMEKO NEPTUNE SERIES TRANSFORMERS. Brand new in makers cartons. All primaries tapped 200-240 v. No. 1 Sec. 30 v. 2A., 6.3 v. 5A., 6.3 v. 1.1A., 6.3 v. 0.3A. 47/6, carr. 5/-. No. 2 450-400-0-400-450 v 180 /MA, 6.3 v. 3A, 6.3 v. 3A, 6.3 v. 4A, 5 v. 3A. 49/6, carr. 6/–. No. 3 500-0-500 v. 120 /MA, 6.3 v. 5A., 6.3 v. 3A,. 5 v. 3A., 45/–, P.P. 5/–. No. 4 6.3 v. 6A., 6.3 v. 2½A., 6.3 v. 1.5A., 6.3 v. 1A. 25/–. P.P. 4/–. No. 5 Two Sec. Windings of 4-6.3 v., 2 amps. 6 kv., D.C. Working, 25/–, P.P. 4/–.

GARDNERS FILIMENT TRANSFORMERS

Pri. Tapped 200-220-240 v. Sec. 6.3 v. 15A., 6.3v. 3A., 6.3 v. 3A. 6.3 v. 2A., 6.3 v. 2A., 6.3 v. 0.6A. 37/6, P.P. 4/–.

GARDNERS EHT TRANSFORMERS

Pri. Tapped, 200, 220, 240 v. Sec. 1500 v. 10 /MA, RMS 19/6, P'P. 2/6. Pri. Tapped 200, 220, 240 v. Sec. 4000 v. 10 /MA. 2-4 v. 2A. 4 kV Wkg.. 4 v. 1.5A., 4kV Wkg. 65/–, carr. 5/–.

26 KVA AUTO TRANSFORMERS

240/125 volts. Base 14 x 19 Ins. H. 23ins. approx Weight 2½ cwt. £35 Ex-Warehouse. Admiralty Isolation Transformer, 230/230 v. 4.6 kVA Test to earth 3 kV. Base 17 x 16ins.
H. 18ins. £19/10/– Ex-Warehouse.

HEAVY CURRENT TRANSFORMERS
LIMITED NUMBER ONLY

Pri 230 v. Sec. T 4-6-11 v. 200 a. £10/19/6. Carr. 10/–. Pri. T 200-260 v. and 100-130 v. Sec. T 2 28, 29, 30, 31 v. 25 a. conservatively rated £6/15/-. Carr. 10/–. Pri. T 210-250 v. and 105-115 v. Sec. 27 v. 60 a. Totally enclosed new in maker's cases, £12/10/-. Carr. 10/-. Pri. 200, 225, 240 v. Sec. T 12, 18, 20, 24, 30, 36 v. 10 a. £5/5/-. Can 7/6. Pri. T 200-220, 240 v. Sec. T. 50, 70, 73 v. 15 a. £6/19/6. Carr. 10/–. Pri. 200, 220, 240 v. Sec. T. 100, 150, 155 v. 22 a. £9/19/6. Carr. 10/–. Pri. 240 v. Sec. T 53.5, 55.2 v. 6 a. C core £3/17/6. Carr. 6/–.

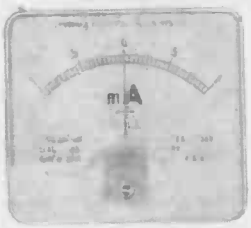
HEAYBERD TRANSFORMERS. Pri. T 200-240 v. Sec. 12 v. 4 a. Brand new. Fraction of maker's price. 15/-. P.P. 2/6.

SEW PANEL METERS

MANUFACTURED BY SHINOHARA ELECTRICAL INSTRUMENTS LTD., JAPAN. FAMOUS ALL OVER THE WORLD FOR THE QUALITY, DEPENDABILITY AND ACCURACY OF THEIR INSTRUMENTS.
The comprehensive range below is available ex-stock. Other ranges to special order. Special quotations for quantities.

S.A.E. FOR ILLUSTRATED LEAFLET

CLEAR PLASTIC METERS



Type MR.38P. 1 21/32in. square fronts.

50µA	32/6	750mA	22/6
100µA	29/6	1A D.C.	22/6
200µA	27/6	2A D.C.	22/6
500µA	25/-	5A D.C.	22/6
50-0-50µA	29/6	3V D.C.	22/6
100-0-100µA	27/6	10V D.C.	22/6
500-0-500µA	22/6	20V D.C.	22/6
1-0-1mA	22/6	50V D.C.	22/6
1mA	22/6	100V D.C.	22/6
2mA	22/6	150V D.C.	22/6
5mA	22/6	300V D.C.	22/6
10mA	22/6	500V D.C.	22/6
50mA	22/6	750V D.C.	22/6
100mA	22/6	15V A.C.	22/6
150mA	22/6	50V A.C.	22/6
200mA	22/6	150V D.C.	22/6
300mA	22/6	300V A.C.	22/6
500mA	22/6	500V A.C.	22/6
		'8' Meter 1mA	29/6

Type MR.52P. 2in. square fronts.

50-0-50µA	57/6	50-0-50µA	57/6
100µA	47/6	100-0-100µA	47/6
500µA	37/6	1mA	32/6

Type MR.52P. 2in. square fronts (Cont.)

5mA	32/6	300V A.C.	32/6
10mA	32/6	'8' Meter 1mA	39/6
50mA	32/6	*1A A.C.	32/6
100 mA	32/6	*5A A.C.	32/6
500 mA	32/6	*10A A.C.	32/6
1A D.C.	32/6	*20A A.C.	32/6
5A D.C.	32/6	*30A A.C.	32/6
300V D.C.	32/6		

Type MR.85P. 4in. × 4¼in. fronts.

50µA	69/6	1 amp. D.C.	45/-
100µA	59/6	5 amp D.C.	45/-
200µA	55/-	15A D.C.	45/-
500µA	49/6	30A D.C.	45/-
50-0-50µA	69/6	*1A A.C.	45/-
100-0-100µA	59/6	*5A A.C.	45/-
500-0-500µA	49/6	*10A A.C.	45/-
1-0-1mA	45/-	*20A A.C.	45/-
1mA	45/-	*30A A.C.	45/-
5mA	45/-	50V D.C.	45/-
10mA	45/-	150V A.C.	45/-
50mA	45 -	300V D.C.	45/-
100mA	45 -	15V A.C.	45/-
500mA	45/-	300V A.C.	45/-

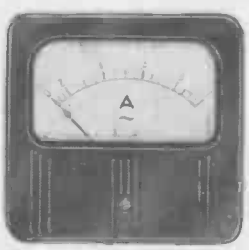
Type MR.65P. 3¼in. × 3¼in. fronts.

50µA	59/6	50A D.C.	42/6
100µA	49/6	*1A A.C.	35/-
500µA	39/6	*5A A.C.	35/-
50-0-50µA	59/6	*10A A.C.	35/-
100-0-100µA	49/6	*20A A.C.	35/-
VU meter	59/6	*30A A.C.	35/-
1mA	35/-	10V D.C.	35/-
5mA	36/-	50V D.C.	35/-
10mA	35/-	150V D.C.	35/-
50mA	35/-	300V D.C.	35/-
100mA	35/-	15V A.C.	35/-
500mA	35/-	50V A.C.	35/-
1A D.C.	35/-	150V A.C.	35/-
5A D.C.	35/-	300V A.C.	35/-
15A D.C.	35/-	500V A.C.	35/-
30 A D.C.	35/-		

BAKELITE PANEL METERS

Type MR.65. 3¼in. square fronts.

25µA	65/-	30A D.C.	29/6
50µA	49/6	50A D.C.	29/6
100µA	39/6	*1A A.C.	29/6
500µA	35/-	*5A A.C.	29/6
50-0-50µA	42/6	*10A A.C.	29/6
100-0-100µA	39/6	*30A A.C.	29/6
500-0-500µA	35/-	*50A A.C.	29/6
1-0-1mA	29/6	5V D.C.	29/6
50mV	39/6	10V D.C.	29/6
100mV	39/6	30V D.C.	29/6
1mA	29/6	50V D.C.	29/6
5mA	29/6	150V D.C.	29/6
10mA	29/6	300V D.C.	29/6
50mA	29/6	*30V A.C.	29/6
100mA	29/6	*50V A.C.	29/6
500mA	29/6	*150V A.C.	29/6
1A D.C.	29/6	*300V A.C.	29/6
5A D.C.	29/6	300V A.C.	35/-
15A D.C.	29/6	VU Meter	49/6



*Moving iron, all others moving coil.

MULTI-METERS

Brand New—Fully Guaranteed—Lowest ever prices.
Supplied with leads, batteries, instructions

MODEL PT-34. 1,000 O.P.V. 0/10/50/250/500/1,000 v. A.C. and D.C. 0/1/100/500 MA. D.C. 0/100 kΩ 39/6. P. & P. 1/6.

MODEL 500. 30,000 O.P.V. 0/.5/1/2.5/10/25/100/250/500/1,000 V. D.C. 0/2.5/10/25/100/250/500/1,000 V. A.C. 0/50µA/5/50/500mA. 12 amp. D.C. 0/60/K6 Meg/60 Meg.Ω 88/17/6. Post Paid.

MODEL NH201 30,000 O.P.V. 0/.25/1/10/50/250/500/1,000 v. D.C. 0/10/50/250/500 v. A.C. 0/50µA/10/250 MA. 0/5/K500K/5 Meg.Ω 99/6. P. & P. 2/6.

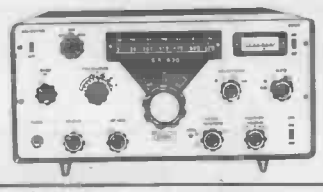
MODEL ITI-2. 20,000 O.P.V. 0/5/25/250/500/2,500 v. D.C. 0/10/50/500/1,000 V. A.C. 0/50µA/25/250 mA. D.C. 0/60K/6 Meg. Ω. .02-3 MFD. 78/6. P. & P. 2/6.

MODEL AR-620 20,000 O.P.V. 0/10/50/250/500/1,000 v. A.C. and D.C. 0/500µA/10/250mA. 0/10K/100K/1 Meg.Ω. 250 PF—.02 MFD. 0-500 Henrys 92/6. P. & P. 2/6.

MODEL 250J. 2,000 O.P.V. 0/10/50/500/2,500 V.D.C. 0/10/50/500/2,500 V.A.C. 0/2 Meg. Ω. 0/250 mA. −20 to +36 db. 49/6. P. & P. 2/6.

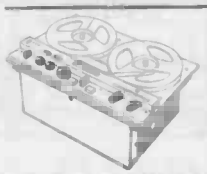
G. W. SMITH & CO (RADIO) LTD

3-34 Lisle St., London, W.C.2 ALSO SEE OPPOSITE PAGE



STAR SR.600 AMATEUR COMMUNICATION RECEIVER.

New crystal controlled triple conversion de luxe 80-10 metre band receiver. Extremely high sensitivity, selectivity and stability. Special features include 3 I.F. stages, crystal controlled oscillator, 4 section L/C filter, 'S' meter, B.F.O. A.N.L., 100 kc/s. crystal calibrator, etc. Supplied brand new and guaranteed. 95 GNS. S.A.E. for full details.



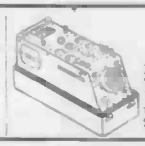
PROFESSIONAL 4-TRACK STEREO RECORD AND PLAYBACK TAPE DECK

Complete with 4 valve/4 transistor pre-amplifier. Will record and play back ¼ track stereo and ¼ track mono at 7½ or 3¾ I.P.S. Twin meter level indicators, digital counter. Mic/gram/tuner inputs. Audio output 500 MW Bias and Erase 80 kc. Response 40-18,000 C.P.S. at 7½; 40-12,000 C.P.S. at 3¾ I.P.S. Motor 4 pole H.D. induction. Tape size up to 7in. 220/240' v. A.C. Size 15in. × 10¼in. × 6¼in. Line up: 4 × 2B B173, 2 × 12AT7, 1 × 12AU7, 1 × 12BH7. S.A.E. FOR FULL DETAILS. PRICE 42 GNS. CARR. 15/-.

BUILD A QUALITY TAPE RECORDER WITH A MARTIN AUDIOKIT

Complete kit includes Martin 6 valve amplifier with magic eye, Collaro studio tape deck, portable cabinet with speaker and full instructions.
TWO TRACK £26. P. & P. 8/6 or deck 10 GNS., amplifier 11 gns., cabinet and speaker 5 gns.
FOUR TRACK £30. P. & P. 8/6 or deck £13/10/-, amplifier 12 gns., cabinet and speaker 5 gns.
S.A.E. for illustrated leaflet on above and all other Martin Audiokits including new F.M. tuner.

CTS3 SIGNAL GENERATOR



8·9-15·5 mc/s and 20-300 mc/s. Variable precision attenuator. AC mains. Supplied in perfect order less calibration chart. £12/10/-. Carr. 10/-.

OS/8B/U OSCILLOSCOPES

High quality Portable American Oscilloscope. 3in. c.r.t. T/B: 3 c/s-50 kc/s. X Amp: 0-500 Kc/s. Y Amp: 0-2 Mc/s. Power requirements 105-125 v. A.C. Supplied in "as new" condition, fully tested. £25. carr. 10/-. Suitable 230/115 v. Transformer 15/6.

REUTER ¼-TRACK TAPE HEADS

As fitted to Collaro Mk. IV and Studio Decks. High imp. record/play back, low imp. erase. Brand new, 19/6 Pair. Also Minifux ¼ track, set of 3, 29/6; Bradmatic ¼ track, set of 2 92/6. Post extra.

PRECISION COMBINATION VOLTMETER/AMMETER

Two separate instruments housed in polished wood case, 6in. scales with knife edge pointers. Ranges as follows: A.C. and D.C. Volts 0-160-300-600. A.C. and D.C. Current: 0-25-50-150-200 amps. Supplied complete with shunts, leads and leather carrying case. Brand new condition. £9/19/6. Each. Carr. 7/6.

TS-382 F/U AUDIO OSCILLATOR

High quality modern American instrument. Frequency coverage on 4 bands. 0-200 Kc/s. Output impedance 1,000Ω. Output monitoring meter. 7 range output attenuator from 12 microvolts to 12 volts. Operation 115 v. 50-1,000 CPS. Supplied as new. £40. Carr. 20/-.

LELAND MODEL 27 BEAT FREQUENCY OSCILLATORS

Frequency 0-20 Kc/s. on 2 ranges. Output 50Ω or 5kΩ. Operation 200/250 v. A.C. Supplied in perfect order £12/10/-. Carr. 10/-.

AMERICAN RECORDING TAPES

First grade quality American tapes. Brand new and guaranteed. Discounts for quantities.

3in. 225ft. L.P. acetate	4/-
3½in. 600ft. T.P. mylar	10/-
5in. 600ft. std. plastic	8/6
5in. 900ft. L.P. acetate	10/-
5in. 1,200ft. D.P. mylar	15/-
5½in. 1,200ft. L.P. acetate	12/6
5½in. 1,800ft. D.P. mylar	22/6
7in. 1,200ft. std. mylar	12/6
7in. 1,800ft. L.P. acetate	15/-
7in. 1,800ft. L.P. mylar	20/-
7in. 2,400ft. D.P. mylar	25/-

Postage 2/-. Over £5 post paid.

9-TRANSISTOR 2 WAY RADIOS

Super quality. Range up to 5 miles. Complete with all accessories. 225 per pair. Post extra. Also available; 3-TRANSISTOR MODEL. Range up to 1 mile. Complete with all accessories. £9/19/6 per pair. Post extra. (S.A.E. for full details.)

HEADSETS

DLR5. Low imp.	10/6
W.S.88 Low imp. with rubber ear pads	17/6
Chamois padded moving coil	29/6
Ditto with microphone	25/-
S.F.20 High Imp.	11/6

All new. Post extra.

LAFAYETTE HI-FI STEREO HEADPHONES

★ Air cushioned headband ★ Soft rubber ear pads ★ Frequency response. 25 to 15,000 cycles. ★ High sensitivity. Impedance 8 ohms per phone. Supplied complete with all cables wires, overload junction box and 3-connection plug. 82/6. P. & P. 2/6.

MODEL PV-58 VALVE VOLTMETER

11 meg. input. 7 D.C. volt ranges. 1·5-1500 v. 7 A.C. volt ranges 1·5-1500 v. 4,000 Peak to Peak. Resistance 2 ohm to 5000 megohm Decibels −10db to +65db. Supplied brand new with instructions, leads and probe. £12/10/-. P. & P. 3/6.

CLASS D WAVEMETER NO. 1 MK. II

Crystal controlled covering 1.9-8 Mc/s. on 2 bands. 6v. D.C. operation. Supplied brand new with handbook, headset and case. 59/6 Carr. 5/-.

MODEL ZQM TRANSISTOR CHECKER

It has the fullest capacity for checking on A, B and Ico. Equally adaptable for checking diodes, etc.
Spec.: A: 0.7-0.9967.
B: 5-200.
Ico: 0-50 microamps.
0-5 mA.
Resistance for diode 200Ω −1 MEG. Supplied complete with instructions, battery and leads. £6/19/6. P. & P. 2/6.

SILICON RECTIFIERS

250 P.I.V. 750 MA	3/-
400 v. P.I.V. 3 amp	7/6
200 v. P.I.V. 6 amp	5/6
1,000 v. P.I.V. 650 mA	7/6
800 v. P.I.V. 500 mA.	5/6
400 v. P.I.V. 500 mA.	3/6
200 v. P.I.V. 200 mA.	3/-
95 v. P.I.V. 3 amp	5/6
70 v. P.I.V. 1 amp	3/6
150 v. P.I.V. 165 mA.	1/-

Discounts for quantities. Post extra.

STAR SR.40 COMMUNICATION RECEIVER

4 Bands. 550 kc/s.-30 Mc/s. '8' Meter-BFO-ANL-Bandspread Tuning—Built-in speaker. 200/250 v. A.C. Brand new 18½ GNS., carr. 10/-.

LAFAYETTE HA-63 COMMUNICATION RECEIVER

7 valves + Rectifier. 4 Bands. 550 kc/s.-31 Mc/s. '8' Meter-BFO-ANL-Bandspread Tuning 200/250 v. A.C. Brand New. 24 Gns. Carr. paid.

PART EXCHANGE WELCOMED

MARTIN FM TUNER

Six transistor printed circuit superhet design. 88-108 Mc/s. 9 volt operation. Consists of 3 sections sold separately. Total cost to build £12/17/6. S.A.E. for leaflet.

SINCLAIR X10 AMPLIFIERS IN STOCK

Kit £5/19/6. Power Pack £2/14/-. Also Micro 6 59/6. TR750 Amp kit 39/6. Micro Amp 28/6. Micro Injector 27/6.

P.O. MINIATURE HIGH SPEED COUNTERS

4 digit available. 6 v., 24 v. or 50 v. All 7/6 each. P. & P. 9d.

DOUBLE BEAM C.R.T.'s

Cossor 89D	£2	19	6
Dumont K105 IPI	£2	19	6

Brand New. Post 3/6.

MAINS RECORD PLAYERS AND AUTO-CHANGERS

ALL GUARANTEED WITH ARM AND CARTRIDGE

GARRARD SRP-10 PLAYER	£4	17	6
GARRARD AUTOSLIM CHANGER	£6	7	6
GARRARD AUTOSLIM DE LUXE	£6	17	6
GARRARD A.T.5 STEREO	£9	17	6
GARRARD A.T.6	£10	9	6
GARRARD DECCADEC WITH DERAM CARTRIDGE	£15	15	0
GARRARD TYPE A CHANGER	£17	15	0
GARRARD 4H.F.	£15	15	0
B&R G.U.7 PLAYER	£4	7	6
B&R UA15 CHANGER	£6	19	6

P. & P. 2/6 ANY OF ABOVE.

MAINS ISOLATING TRANSFORMERS

230 V. to 230 V. 50 W. 16/6. P. P. 3/-; 100 W. 29/6. P.P. 3/6; 1,000 W. £5. Carr. 10/-.

PLUGS AND SOCKETS

Painton 15 pin in line printed circuit connectors 7/6 pr. Large quantities available. Ditto 32 pin 12/6 pr.

PAINTON MINIATURE JONES. 4 pin 3/6 pr.; 6 pin 4/- pr.; 8 pin 4/6 pr.; 12 pin 5/6 pr.; 18 pin 7/6 pr.; 24 pin 10/6 pr.; 33 pin 12/6 pr. Post extra.

CHASSIS PUNCH SET

Set of 5 popular size hole cutters, ¼in., ⅜in., ½in., ⅝in., ¾in. Supplied complete with punches dies, T drive handle, tapered reamer, fitted leather case and instructions. 49/6. P.P. 2/-.

BEST BUY!

Send 7/- P.O. for full Catalogue and Lists. Open 9 a.m. to 6 p.m. every day Monday to Saturday. Trade supplied.

G.E.C. BRT.402 RECEIVERS

A high-grade 14 valve communication receiver covering 150-385 kc/s. and 510 kc/s to 30 Mc/s. in six bands. Special features include 2 RF stages, 'S' meter. Variable selectivity, B.F.O., ANL, AGC, 600 kc crystal calibrator, slide rule vernier dial with logging scale. Operation for 95-130 v. and 195-250 v. A.C. Output for phones speaker or line. Offered in excellent condition, fully tested and guaranteed. £60, carr. 30/-.

ERSKINE TYPE 13 DOUBLE BEAM OSCILLOSCOPES

Timebase 2 c/s.-750 kc/s. Separate Y1 and Y2 amplifiers. Up to 5.5 Mc/s. callb. at 100 kc/s. and 1 Mc/s. 110/230 v. A.C. Guaranteed perfect £27/10/-, carr. 20/-.

350 MA R.F. METERS

2in. round. Plug in type, 8/6. P.P. 1/6.

12 VOLT TRANSFORMERS

210/240 volt primaries. ½A. 5/9; 1A 10/6; 2A 13/6; 3A 17/6; 5A 25/-; 8A 29/-; 10A 32/6. Post extra.

L.T. TRANSFORMERS

200/250 volt Primaries. 9 or 17 volt 1A 9/9; 2A 14/3; 4A 16/6; 6A 26/-. Tapped 3, 4, 5, 6, 8, 10, 12, 15, 18, 20, 24 or 30 v. 2A 18/6; 4A 27/6; 5A 37/6; 50 volt ½A 13/6; 1A 15/6; 2A 29/6.

L.T. METAL RECTIFIERS

SELENIUM FULL wave bridge.

12/18V	1A	3/9	24/36V	2A	13/6
12/18V.	2A	6/3	24/36V	4A	14/-
12/18V	4A	8/6	24/36V	6A	22/6
12/18V	6A	12/3	24/36V	15A	45/-
12/18V	15A	37/6			
24/36V	1A	7/3	Post extra.		

EMI WM5 CONSUL OSCILLOSCOPES

Available as new. Guaranteed perfect order. £65

AUTO TRANSFORMERS

Step up or step down. Tapped 0/115/200/230/250 v. 20W. 9/-; 60W. 12/6; 75W. 15/6; 150W. 18/6; 200W. 27/6; 300W. 42/6; 500W. 67/6; 1,000W. 90/-; 1,500W. £6 19/6; 3,000W. £7/10/-; 7,500 W. £15.

(*Only tapped 0/110/230 V.) Post extra.

NATIONAL H.R.O. DIALS

Brand new 27/6. P.P. 1/6.

11FT. COLLAPSIBLE WHIP AERIALS

Brand new 8/6. P.P. 2/-.

MINE DETECTOR No. 4A

Will detect all types of metals. Fully portable. Compact, with instructions 39/6 each. Carr. 10/-. Battery 8/6 extra.

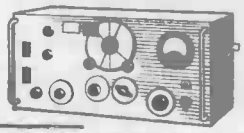
VARIABLE VOLTAGE TRANSFORMERS

Brand New Guaranteed — Fully shrouded. Input 230 v. 50/60 c/s. Output 0-260 v.

1 amp	£4 10/-	12 amp	£18 15/-
2.5 amp	£5/17/6	20 amp	£32 10/-
5 amp	£9/10/-	2.5 amp. portable, metal case with meter, fuses, etc.	£9/17/6
8 amp	£14/10/-		
10 amp	£16/10/-		

MARCONI TF 114G/4 STANDARD SIGNAL GENERATOR

85 kc/s.-25 Mc/s. ±1%. Output variable from 1 μV to 1 volt. Internal sine wave modulation 400 c/s. up to 75% depth. Operation 200/250 volts A.C. Offered in really excellent condition, like new, fully tested and guaranteed. £25, carr. 30/-.



LAFAYETTE 'PRECON' AMATEUR PRE-SELECTOR CONVERTOR

Convertor—20-15-10 metres. Pre-selector—80-40-20-15-10 metres. Crystal controlled—2 RF stages. 200-250 v. A.C. operation. Brand New 19 GNS. Carr. 7/6.

LAFAYETTE TE-46 RESISTANCE CAPACITY ANALYSER

2 PF-2,000 MFD. 2 ohms-200 megohms. Also, checks impedance, turns ratio, insulation 200/250 v. A.C. Brand New £15, carr. 7/6.

TE22 SINE SQUARE WAVE AUDIO GENERATORS

Sine: 20 cps to 200 kc/s. on 4 bands. Square: 20 cps to 30 kc/s. Output impedance 5,000 ohms. 200/250 v. A.C. operation. Supplied Brand New and Guaranteed with instruction manual and leads. £15. Carr. 7/6.

LAFAYETTE TE-20A R.F. SIGNAL GENERATOR

120 kc/s.-390 Mc/s. on 6 ranges. Variable R.F. and A.F. outputs. Large clear scale. Size 7½ × 10½in. × 4½in. 220/250 v. A.C. operation. Brand New £12 19/6, carr. 5/-.

MAIN LONDON AGENTS FOR CODAR EQUIPMENT

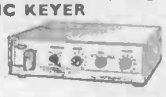
PR.30 Preselector	£4	19	6
PR.30X Self powered	£7	4	0
RQ.10 "Q" Multiplier	£6	15	0
RQ.10X Self powered	£8	2	0
A.T.5 Amateur TX	£16	10	0
A.T.5. Mains P.S.U.	£8	0	0
A.T.5. 12 v. Transistor P.S.U.	£11	5	0
A.T.5. Remote control and Aerial Switching Unit	£2	7	6

Postage extra.

COSSOR 1035 DOUBLE BEAM OSCILLOSCOPES

4in. C.R.T. Calibrated Y1 Amplifier from 50 mV. to 50 v., bandwidth 10 Mc/s. Calibrated Y2 Amplifier from 5 v. to 500 v., bandwidth up to 100 kc/s. Directly calibrated X shift providing time measurement from 15μsec. to 150 milliseconds. Supplied in guaranteed perfect working order. £35. Carr. 20/-.

MODEL DA-1 TRANSISTORISED FULLY AUTOMATIC ELECTRONIC KEYER



230 V. A.C. or Battery operated. Incorporates built-in monitor oscillator, speaker and keying lever. Fully adjustable speeds giving either auto., semi auto, or hold. 7 transistors, 4 diodes. £16/10/-. P. & P. 4/6.

TS-76 20,000 O.P.V. PUSH BUTTON MULTI-TESTER

Large clear plastic scale, simple operation, D.C. volts up to 1,000 v. A.C. volts up to 1,000 v. Resistance up to 10 megohm. Current up to 250 mA Decibels —20 to +36 db. Size 6in. × 4¾in. × 2¼in. Complete with leads, batteries and instructions. £5/5/-. P. & P. 2/-.

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Transistorised Audio Generator 10-100,000 c/s. Sine or square wave. £16/15/-.

Transistorised Signal Generator 150 kc/s.-350 Mc/s. £9/10/-.

Transistorised resistance capacity bridge 1Ω-100 MegΩ, 1 pf-100μF. £8/5/-.

Transistorised Induction bridge 1μH-100H. £18. Mains operated Transistor power supply unit, output 1-15 v. up to 100 mA. £6/10/-.

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ELIZABETHAN TYPE LZ 511 STEREO TAPE RECORDER

A fully professional 4-track, 3 speed Stereophonic Tape Recorder—at almost half price! 4 track record and replay—Mono or Stereo. 3 speeds—7½, 3¾, 1⅞ i.p.s.—fast forward and rewind. Frequency response 40/16,000 c.p.s. at 7½ i.p.s. Output 3 watts per channel to two 8in. x 5in. speakers in detachable enclosures which also form lid of the recorder (supplied with 8ft. extension leads). 2 Vu record level meters; tape position indicator and auto. tape stop; inputs for 2 microphones and 2 radio/pick-ups. Controls include: volume, treble/monitor, bass etc.—duplicated for each channel. Takes 7in. spools. For 200/250 v. 50 c.p.s. Mains operation. Overall size (including speakers) 26 x 13 x 8in. Maker's original List Price 65 Gns.
WIRECOMP'S PRICE 39 Gns. Including 2 crystal microphones, tape and spool. Carriage and Insurance 15/- extra.

PAMPHONIC 3001 INTEGRATED STEREO AMPLIFIER

New, and fully guaranteed. Spec.: 7 watts per channel; freq. response 40 c/s to 20 kc/s; sep. inputs for crystal and magnetic pick-ups, radio and tape; 15 ohms out. sockets for tape recording; volume, bass, treble and balance controls provided. For A.C. mains, 100/250 v. In free standing housing size 13 x 10 x 4¼in. Maker's list price £38/10/-.
WIRECOMP'S PRICE 23 Gns. Post 10/6.

PAMPHONIC 732A SWITCHED RADIO TUNER

Instant pre-selection of 3 medium wave stations and 1 long wave station (easily adjustable to your local frequencies). Self powered—3 valves. For 200/250 v. A.C. Fitted with tone and volume controls for use in conjunction with a power amplifier. In metal case, size 16 x 7 x 3¼in.
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PAMPHONIC 1002A CONTROL UNIT

Inputs for pick-up, radio, tape and microphone. Controls for volume, bass, treble, filter and selector. Fitted with 2 EEC 40 valves.
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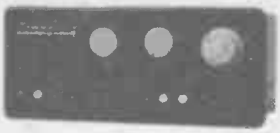
PAMPHONIC 2001A PRE AMP

Sensitivity from 3 to 120 mV. for ¼ v. out. Fitted with 2—ECC40 valves. Inputs for radio, tape, pick-up and microphone with pre-set level controls. Controls for bass, treble filter and selector fitted. Unpowered. Size 10 x 4 x 4in.
WIRECOMP'S PRICE £5.19.6 Post 3/6.

PAMPHONIC 1002B PUSH BUTTON CONTROL UNIT/PRE AMP



A correction network is provided for every important recording characteristic with separate inputs or radio, tape and mic. Max. output is 1 volt. Unpowered. Volume, bass, treble and filter controls. 1—EF86 and 2—ECC81 valves fitted. Size 10 x 4 x 5in. New and boxed. Maker's list price £25/4/-.
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PAMPHONIC S1 SPEAKER UNIT

Cabinet type forward facing system. Fitted with 10 x 6in. elliptical double cone speaker. Wood cabinet size 15 x 12 x 11in., finished in medium walnut. New, and guaranteed. List Price 10 Gns.
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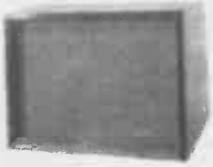

LEAK POWER AMPLIFIERS

For 200-250 v. A.C. mains. Fitted with integrated volume, bass and treble controls, with 100V line source output. New and boxed.
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MODEL HE 30—PRICE 33 Gns.
Also available as a kit—PRICE 25 Gns.
H.P. Terms (Ready Built): £6/13/- dep. and 11 monthly payments of £2/16/-. Total H.P.P. £37/9/-.

MODEL HE 40—PRICE 19 Gns.
H.P. Terms: £4 dep. and 11 monthly payments of £1/12/-. Total H.P.P. £21/12/-.

MODEL HE 80—PRICE 59 Gns.
H.P. Terms: £12/19/- dep. and 11 monthly payments of £4/13/-. Total H.P.P. £66/17/-.

All available from stock—brand new and boxed with full data. See "W.W." March, '65, for full details. No kits avail. for Models HE 40 and 80.

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4in.	Triple play, 900ft. Mylar base	17/6
5in.	Double play, 1,200ft. Mylar base	15/-
5in.	Long play, 900ft. Acetate base	10/-
5in.	Standard play, 600ft. P.V.C. base	8/6
5in.	Triple play, 1,800ft. Mylar base	35/-
5¼in.	Double play, 1,800ft. Mylar base	22/6
5¼in.	Long play, 1,200ft. Acetate base	12/6
5¼in.	Standard play, 850ft. P.V.C. base	11/6
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7in.	Long play, 1,800ft. Mylar base	19/6
7in.	Double play, 2,400ft. Mylar base	25/-
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"Sound 30"—30 watt valve model, 8 inputs .. 35 Gns.
Matching Speaker System for the "Viking" amplifiers ..... 33 Gns
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0-100mA.	3½in.	A.C.	22/6
150-0-1,500mA.	3½in.	D.C.	29/-
0-100mA.	3½in.	D.C.	32/6
0-5v.	3½in.	A.C.	22/6
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*Weston as usually used also in H.R.O. as "S" meter. **Projection type.

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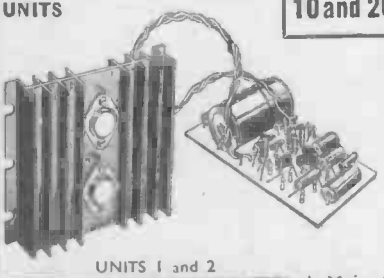

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● **Power Amplifiers,** 10 watts push-pull RMS music power—6 transistor design. Panel size 4 x 2½ x ¾in. H/S, 4 x 4 x 1in.
100 mV. to 33 k input.
Response 40 c/s. to 20 kc/s.
★ Unit 1. 12/15 ohm O/P. 40 volt supply
PRICE BUILT **£5.19.6** P.P. 2/6.
★ Unit 2. 3 to 5 ohm output version. 24 volt supply.
PRICE BUILT **£5.10.0** P.P. 2/6.

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★ **Mains Units.** 59/6 to power one amplifier or 69/6 to power two. (state 3/5 or 12/15 ohm version).
● **Preamplifiers.** Mono and stereo versions. 8 inputs, sensitivities 1½ mV. to 300 mV. 1k to 500k. Response 30 c/s. to 20 kc/s. Complete range of controls, battery operated or from mains units.
★ Mono Full Function (Unit 3). Size 9½x2½x2in.
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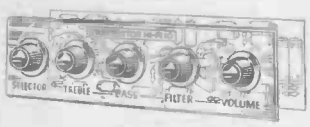
Low noise Hi-Fi Units.
(Brown and gold front panel plate 8/6.)



UNIT 3

★ Multi-input (Unit 4). Simplified version of Unit 3. Size 5 x 2½ x 2in.
PRICE BUILT **65/-** P.P. 1/6 Front panel plate 6/6.
★ Stereo Preamplifier (Unit 5) for use with two of units 1 or 2. Size 9 x 3½ x 1¾in.
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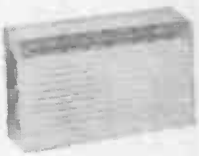

★ 6-transistor design.
★ Printed circuit.
★ Push-pull output.
★ "Cleartone" 2½in. speaker fitted.
★ Moulded high impact attractive cabinet.
★ Size 5 x 3 x 1¾in., slow motion tuning.

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★ 6-transistor push-pull printed circuit designs.
★ Four 3 to 5 ohm speakers.
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★ 4 watt 12/18 volts, 1½ watt, 9/12 volts.
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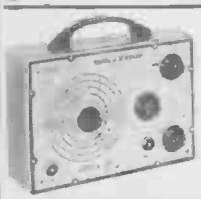

● TRANSISTOR PORTABLE TEST EQUIPMENT

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★ Two prebuilt and aligned units plus metal work and panel.
★ 88 to 108 Mc/s tuning range.
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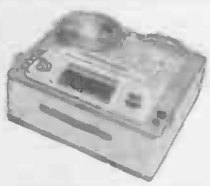
★ 6-transistor superhet, printed circuit design.
★ Size 9½ x 3½ x 4in.

TOTAL COST TO BUILD **£12.17.6** P.P. 2/6.

(All units sold separately.)

● 2 AND 4 TRACK RECORDERS TO ASSEMBLE

TOTAL COST TO BUILD



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★ Printed circuit, prebuilt units.
★ Complete in every detail.

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★ EP30K	30	,,	,,	£6	10	0
★ Model 500	30	,,	,,	£8	17	6
★ EP50K	50	,,	,,	£8	15	0
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★ Model 700. Professional meter, 20 k/ohm/volt with AC/DC volts, resistance DC and AC current. Size 7½ x 5½ x 3½in.
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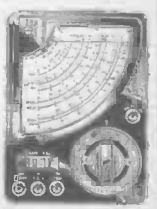

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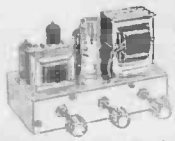
3-VALVE AUDIO AMPLIFIER MODEL HA34



Designed for Hi-Fi reproduction of records. A.C. mains operation. Ready built on plated heavy gauge metal chassis, size 7½in. w. × 4in. d. × 4½in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker, separate bass, treble and volume controls. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. The HA34 has been specially designed for us and our quantity order enables us to offer them complete with knobs, valves, etc., wired and tested for only £4/5/-. P. & P. 6/-.

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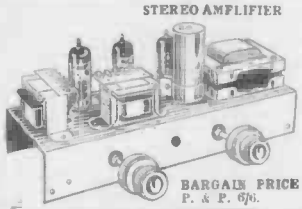

Incorporating 2 ECL82s and 1 EZ80; heavy duty, double wound mains transformer. Output 4 watts per channel. Full tone and volume controls. Absolutely complete.

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- Peak output in excess of 1½ watts.
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GARRARD AT60	£10 10 0
GARRARD Auto-Slim	£6 10 0

Carr. 6/6 on each

All the above units are complete with t/o mono head with sapphire styli or can be supplied with stereo head at **12/6** extra.

BRAND NEW CARTRIDGE BARGAINS!

ACOS 71-5. Single-sided Crystal Cartridge for Stereo and L.P. records. Complete with diamond stylus and universal mounting bracket. List price £2/0/4. **OUR PRICE 18/6.** P. & P. 1/-.

GARRARD GC2 Mono complete. List price 24/11. Our Price **12/6.** P. & P. 1/-.

RONETTE STEREO 105 CARTRIDGE. Stereo/LP/78 complete with two sapphires. Original list price **67/9.** Our Price **24/-.** P. & P. 1/-.

QUALITY RECORD PLAYER AMPLIFIER
A top-quality record player amplifier. This amplifier (which is used in a 29 gn. record player) employs heavy duty double wound mains transformer, ECC83, EL84, EZ80 valves. Separate bass, treble and volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. w. × 2¾in. d. × 5½in. h. Ready built and tested. **PRICE 69/6.** P. & P. 4/9. ALSO AVAILABLE mounted on board with output transformer and 6in. speaker ready to fit into cabinet below. **PRICE 89/6.** P. & P. 5/9.

QUALITY PORTABLE R/P. CABINET
Uncut motor board. Will take above amplifier and B.S.R. or GARRARD Autochanger or Single Record Player Unit. Size 18 × 14 × 8½in. **PRICE £3/9/6.** Carr. 7/6.

4-WAY NON-TANGLE TELEPHONE CABLE. Latest spring-back coil type, extends 12in. to 5ft. Complete with rubber bushes, **4/6** each. P. & P. 1/6.

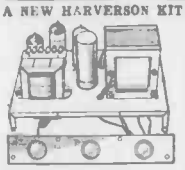
Precision 6-minute Delay Action Switch, Clockwork actuated. Made by Smiths. Separate switching actions at intervals up to 6 mins. Each switch action designed for current loading up to 15 amps at 250 volts. Suitable for photographic timer, sequence switching operations, etc., etc. Brand new and unused units offered at a fraction of their true value. **OUR PRICE 10/-** each. P. & P. 1/6 (3 or more post free). Special quotations for quantity

10/14 WATT HI-FI AMPLIFIER KIT

A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86, and EZ80 rectifier. Simple instruction booklet 1/6. (Free with parts.) All parts sold **separately. ONLY £8 19/6.** P. & P. 8/6. Also available ready built and tested complete with standard input sockets. **£8/15/-.** P. & P. 8/6.

VYNAIR & REXINE SPEAKER & CABINET FABRICS. Approx. 54in. wide. Usually 35/- yard. **OUR PRICE 13/6** per yard length. P. & P. 2/6. (Min. 1 yard). S.A.E. for samples.

A NEW HARVERSON KIT FOR THE HOME CONSTRUCTOR



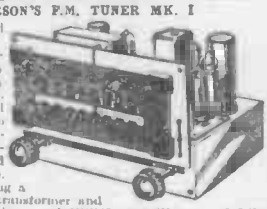
A really excellent, all purpose A.C. mains 200/240 v.

AMPLIFIER KIT.

TYPE H8L "FOUR" 3-VALVE, 4 WATT USING ECC83, EL84, EZ80 VALVES.

Special features include: ★ Heavy duty double-wound mains transformer with electrostatic screen. ★ Separate bass, treble and volume controls, giving fully variable boost and cut with minimum insertion loss. ★ Heavy negative feedback loop over 2 stages ensures high output at excellent quality with very low distortion factor. ★ Suitable for use with guitar, microphone or record player. ★ Provision for remote mounting of controls or direct on chassis. ★ All this builds on to a chassis size only 7½in. wide × 4in. deep. Overall height 4½in. ★ All components and valves are brand new. ★ Very clear and concise instructions enable even the inexperienced amateur to construct with 100% success. ★ Supplied complete with valves, output transformer (3 ohms only), screened lead, wire, nuts, bolts, solder, etc. (No extras to buy.) **PRICE 79/6.** P. & P. 6/-. Comprehensive circuit diagram, practical layout and parts list 2/6 (free with kit).

HARVERSON'S F.M. TUNER MK. I



- F.M. tuning head by famous maker.
- Guaranteed non-drift. • Permeability tuning. • Frequency coverage, 88-100 Mc/s.
- OA81 balanced diode output. • Two I.F. stages and discriminator. • Attractive maroon and gold dial (7 × 3in. glass).
- Self powered, using a good quality mains transformer and valve rectifier. • Valves used ECC85, two EF80s, and EZ80 (rectifier). • Fully drilled chassis. • Size of completed tuner 8 × 6 × 5½in. • All parts sold separately. Set of parts if purchased at one time **£5/19/6.** plus 8/6 P.P. and ins. Circuit diagram and instructions 1/6 post free. **Mark II Version** as above but complete with magic eye, front panel and brackets, **£6/12/6.** P. & P. 8/6. **Mark III Version** as Mark I but with output stage (ECL82) and tone control. **£7/7/-.** P. & P. 8/6. Handsome Metal Cabinets. Choice of Black or Green. To fit Mark I. **25/-.** P. & P. 3/-. To fit **Mark II. 17/6.** P. & P. 3/-.

SPECIAL PURCHASE! TURRET TUNERS
by famous maker

Brand new and unused. Complete with PCC84 and PCF80 valves. 34-38 Mc/s. I.F. Biscuits for Channels 1 to 5 and 8 and 9. Circuit diagram supplied. **ONLY 25/- each.** P. & P. 3/6.

GÖRLER F.M. TUNER HEAD
88-100 Mc/s. 10.7 Mc/s. I.F. **15/-** P. & P. 2/-. (ECC85 valve 8/6 extra)

TAPE DECKS

B.S.R. MONARDECK (Single speed) 3¾in. per sec., simple control, uses 5in. spools, **£6/15/-,** plus 7/6 carr. and ins.

COLLARO STUDIO DECK. 3 motors, 3 speeds, push button control. Up to 7in. spools **£10/10/-.** P. & P. 7/6. (Tapes extra on both.)

SPECIAL OFFER!! BRAND NEW HEAVY DUTY 12 INCH SPEAKERS

Response 45 c/s.-13 kc/s. 1½in. voice coil. Available in 3 or 15 ohm. Guaranteed full 15 watts British rating. Heavy cast aluminium frame. These are current production by world famous maker and as they are offered well below list price we are not permitted to disclose the name.

LIMITED NUMBER ONLY. UNREPEATABLE AT 89/6. P. & P. 5/-.

Also 25 w. guitar model available at **£5/5/-.**

MATCHED PAIR OF 2½ WATT TRANSISTOR DRIVER AND OUTPUT TRANSFORMERS. Stock size 1½ × 1½ × ¾in. Output trans. tapped for 3 ohm and 15 ohm output. 10/- pair, plus 2/- P. & P. Worth double.

BRAND NEW PLESSEY. 12 v. 4 pin non-sync. vibrators. Type 12 1.48D. **ONLY 8/6.** P. & P. 1/6 each.

ROLA CELESTION. Approx. 9 x 6in. 3 ohm Middle register speaker. 10/6. P. & P. 3/-.

HARVERSON SURPLUS CO. LTD.
170 HIGH ST., MERTON, S.W.19. CHErrywood 3985

Open all day Saturday Early closing Wed., 1 p.m.

A few minutes from South Wimbledon Tube Station. *(Please write clearly)*

Overseas P. & P. charged extra. S.A.E. with all enquiries.

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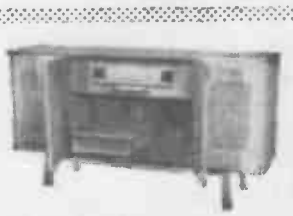
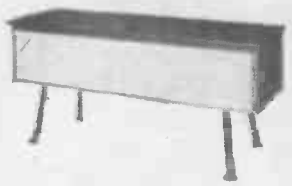
EQUIPMENT CABINETS OF DISTINCTION



IMPERIAL

- Illustrated in this advertisement are two fine cabinets from the Lewis Radio Range.
- These Cabinets are just two of a really extensive range.
- Each one carefully made by British Craftsmen and soundly constructed from the best materials available.



LOWBOY

LEWIS radio

- Fill in coupon below to obtain FREE catalogue showing this wonderful range of cabinets.

FREE **THE NEW LEWIS CATALOGUE** Designed to assist your choice of cabinet. The new Lewis Radio Cabinet Catalogue —the most comprehensive ever prepared. Sent absolutely FREE

Please send your FREE 24-page cabinet catalogue:

NAME .....

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CAPITALS PLEASE

LEWIS RADIO
100 Chase Side, Southgate, London, N14
Telephone: Palmers Green 3733/9666

GEE's TAPE!

5in.	Std.	600ft.	8/6
7in.	Std.	1,200ft.	12/6
5in.	L.P.	900ft.	10/-
5½in.	L.P.	1,200ft.	12/6
7in.	L.P.	1,800ft.	15/-
4in.	D.P.	600ft.	9/-
5in.	D.P.	1,200ft.	15/-
5½in.	D.P.	1,800ft.	22/6
7in.	D.P.	2,400ft.	25/-

P. & P. 2/- per order (Over £3 post free).

TENSILISED TRIPLE PLAY

3½in.	600ft.		15/-
4in.	900ft.		17/6
5in.	1,800ft.		35/-
5½in.	2,400ft.		45/-
7in.	3,600ft.		58/6

SPARE SPOOLS

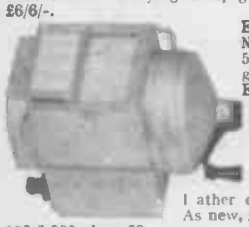
2½in. 1/6; 3in. 1/-; 3½in. 1/6; 4in. 1/8; 5in. 2/-; 5½in. 2/-; 7in. 2/6; 8½in. 4/6; 10in. 11/-.

SPECIAL DISCOUNT FOR TAPE QUANTITIES. Send S.A.E. for Tape list.

OUTSTANDING BUYS IN QUALITY MULTIMETERS

100,000 o.p.v. Model 370-N. Price £14/14/-.
30,000 o.p.v. Model 500. Price £8/17/6.
20,000 o.p.v. Model C.T.500. Price £5/5/-.
4,000 o.p.v. Model H20. Price 79/6.
All complete with test leads, battery, instructions and fully guaranteed.

EVERSHED & VIGNOLES. Wee Megger 100 v., with leather carrying case, good working order, £6/6/-.



EVERSHED & VIGNOLES Series II, 500 v. Megger in good cond. £18/18/-.

EVERSHED & VIGNOLES MEGGER CIRCUIT TESTER (low reading ohm meter). 2 ranges 0-3, 0-30 ohm. Complete with leather case and test leads. As new, £6/6/-. Ditto 0-500, 100-5,000 ohms £6.

E. & V. BRIDGE MEGGER 500 v., with leather case. Perfect working order, £40.

G.P.O. DESK TELEPHONES

Black, complete with bell, handset, standard auto dial. Guaranteed sound, ex-office equipment. Bargain price **35/-** P. & P. 3/6.

COLLARO "STUDIO" TAPE TRANSCRIPTORS. Brand new in original cartons. 3 speeds, 1⅞, 3¾, 7½ i.p.s. 3 motors, digital counter, etc. Complete with 7in. spools, instructions and fixings, A.C. 200/230 v. operation. **SPECIAL PRICE 10 GNS.** Carr. paid.

MICROPHONES

BM3 Crystal Stick, 39/6. P. & P. 2/-.
PA.46 Dual Imp. Dynamic 84/-. P. & P. 2/6.
PA.17 Studio Twin Crystal, 42/-. P. & P. 2/6.
Telescopic Floor Stand, 55/-. Carr. 5/-.
Send S.A.E. for Microphone list.

WANTED FOR CASH!!
Good quality modern P.A. Equipment, Test Equipment, Hi-Fi Equipment, what have you? Single items or quantities. Offers by return.

AUTO TRANSFORMERS. Step up, step down, 110/115, 220/230 v. Fully shrouded terminal block connectors. 150 w. 32/6; 300 w. 47/6; 500 w. 67/6; 750 w. 77/6; 1,000 w. 90/-; 1,200 w. 117/6; 1,500 w. 139/6; 1,750 w. 175/-; Carriage 5/- on each type.

G.P.O. STANDARD 19in. HEAVY DUTY EQUIPMENT RACKS
5ft. 6in. Angle Uprights, £5. Carr. 15/-.
6ft. Channel Uprights, £6/10/-. Carr. 20/-.
7ft. Channel Uprights, £8. Carr. 25/-.
All with Heavy Duty Base.

GEE BROS. RADIO LTD.

15 LITTLE NEWPORT STREET, LONDON, W.C.2. GER. 6794/1453

Open 9-6 Mon. to Fri. 1 p.m. Sat.
Adjoining Leicester Square Tube

SAVE £££'s AT GEE'S!!!

P.A. EQUIPMENT

We offer a full range of all Amplifiers, Transistor or Valve, from 250 m/w to 50 watts output, also Speakers, Horns, Mikes, Floor-Stands, Cabinets, suitable for all sound applications. A small selection below—may we quote for your requirements.

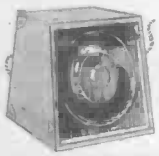
SUPER POWER LOUD HAILER MODEL 2583. Hearing range 1,000ft. Lightweight self-contained portable, with detachable dynamic directional type microphone with cardiod polar diaphragm. Fully transistorised power amplifier. Long battery life. Ideal for all outdoor events. Brand new and guaranteed. **PRICE 22 Gns.**

JUNIOR MODEL "BULL HORN." Range 200ft. **PRICE £4/15/-** complete.

RE-ENTRANT LOUD HAILERS (Ex. Govt.) Heavy duty 20 watts, all metal, 15 ohms. Dia. 15in., length 15in. (approx.). Brand new and boxed, £9. Carr. 10/-. Ditto reconditioned £6/10/-. Carr. 10/-.

EXPONENTIAL HORNS BY FAMOUS MAKER OF P.A. SYSTEMS

20 watt, 15 ohm speech coil, 30in. long, 20in. square flare. Good condition. £7/10/-. Carr. 12/6.



TRUVOX/TANNOY LOUD HAILERS
With 180 ohm line transformer and condenser. Impedance 7½ ohms, handling capacity 8 watts. Complete in slope-front wooden case, 30/-. Carr. 5/-. (Spare diaphragms 12/6 each.)

VIKING TRANSISTOR "50." Superb 50-watt amplifier for music, P.A., guitars, groups, etc. 4 inputs with mixing facilities plus reverberation. Output for 15 ohm speakers. A.C. 200/250 v. operation. Size 22in. × 10in. × 6in. Brand new and fully guaranteed. **GEE'S PRICE 42 Gns.** Carr. 7/6.

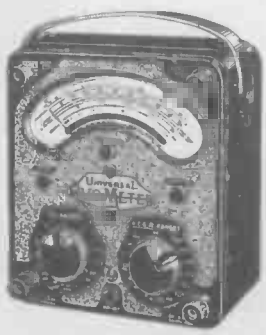
VIKING SOUND 30. Valve model similar to above, but with 8 inputs and 4 separate volume controls. A.C. 200/250 v. operation. Size 20in. × 9in. × 6in Brand new and fully guaranteed. **GEE'S PRICE 32 Gns.** Carr. 7/6.

5WW—091 FOR FURTHER DETAILS.

AVO

STOCKISTS

MULTIMINOR MK. IV



MODEL 8 MK. III

REPAIR SERVICE 7-14 DAYS

We specialise in repair, calibration and conversion of all types of instruments, industrial and precision grade to BSS.89.

Release notes and certificates of accuracy on request.

Suppliers of Elliott, Cambridge and Pye instruments.

LEDON INSTRUMENTS LTD

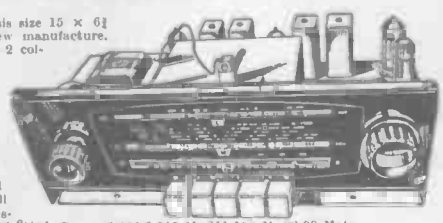
76-78 DEPTFORD HIGH STREET, LONDON, S.E.8.

TEL.: TIDeway 2689

E.I.D. & G.P.O. APPROVED **CONTRACTOR TO H.M. GOVT.**

5WW—137 FOR FURTHER DETAILS.

BRAND NEW AM/FM (V.H.F.) RADIOGRAM CHASSIS AT £13.13.0 (CARRIAGE PAID)



A.C. ONLY. Chassis size 15 × 6½ × 5½in. high. New manufacture. Dial 14½ × 4in. in 2 colours, predominantly cream. Pick-up, Extension Speaker, Ae., E., and Dipole Sockets. Five "piano" push buttons — OFF L.W., M.W., F.M. and Gram. Aligned and tested. With all valves and O.P. Transformer. Tone Control fitted. Covers 1,000-1,900 M; 200-500 M; 88-98 Mc/s. Valves EZ80 rect., ECH81, EF89, EABC80, EL84, ECC85. 10 × 6in. ELLIPTICAL SPEAKER 25/- to purchasers of this chassis.
TERMS: £3/10/- down and 5 monthly payments of £2/4/-.
ALTERNATIVE DESIGN. LW 1,000-2,000M; SW 9-15 mc/s., MW 190—475M VHF 87-100 mc/s., gram position. Otherwise similar to above chassis. Price £15/15/- (carr. paid), terms £3/10/- down and 6 monthly payments of £2/4/-.

PUSH-PULL OUTPUT MONO-AURAL AMPLIFIER
Output Transformer for 2-3 ohm speaker. Controls are bass, treble and volume. Output 8 watts. Input 200-250 v. A.C. Valves EZ80, ECC83 and 2-EL84. Overall size 12in. × 3½in. (chassis) plus knobs × 5in. over valves. The front control panel is normally screwed to the chassis but may be removed and used as a "flying panel". Price £5/5/-. (Post 6/-).

BATTERY ELIMINATOR
For 4 low consumption valves (96 range) 90 v. 15 mA. and 1.4 v. 125 mA., 42/6 (4/- post). 200-250 v. A.C. Also for 250 mA. 1.4 v. and 90 v. 15 mA. at same price. Two units to replace existing batteries.

TAPE RECORDER AMPLIFIER
Fully built. Front panel 12½in. × 3in. Chassis size 10½in. × 5in. × 4in. Valves EF86, ECC83 and 2EL84. Controls (1) MIC. Vol. (2) Tuner/P.U. Vol. (3) Play back or monitor. (4) Tone. 2 jack sockets for Tuner/P.U. and MIC-switch for superimpose. Separate power pack containing transformer and rectifier.
For Collaro studio deck only. Price £8/14/- (6/- P. & P.).

Send 6d. for 20-page illustrated catalogue. All New Goods. Delivered by return, (C.O.D. 2/6 extra).

ALL ITEMS GUARANTEED 12 MONTHS. VALVES 3 MONTHS

We regret we cannot execute overseas orders.

GLADSTONE RADIO

66 ELMS ROAD, ALDERSHOT, HANTS. Aldershot 22240. (1 min. from station and buses.) Closed Wednesdays.

Why NOT BUILD ONE OF OUR PORTABLE TRANSISTOR RADIOS . . .

BACKED BY OUR SUPER AFTER SALES SERVICE

NEW TRANSONA FIVE

★ 7 Stages 5 transistors and 2 diodes.

Covers M. and L. Waves and Trawler Bands, a feature usually found in only the most expensive radios. On test, House, Light, 208, and many Continental stations were received loud and clear. Designed round supersensitive Ferrite Rod Aerial and new type fine tone super dynamic 2½in. speaker, attractive case in grey plastic with red grille. Size 6¼ × 4½ × 1¼in. approx.

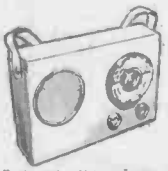
Total cost of all parts NOW ONLY **42/6** P. & P. 3/6.
Parts price list and easy build plans 2/-.

POCKET FIVE

★ 7 Stages—5 transistors and 2 diodes. Covers Medium and Long Waves and Trawler Band, a feature usually found in only the most expensive radios. On test, Home, Light, Luxembourg and many Continental stations were received loud and clear. Designed round supersensitive Ferrite Rod Aerial and fine tone 2½in. moving coil speaker, built into attractive black case with red speaker grille. Size 5½ × 4¼ × 3¼in. (Uses 1289 battery, available anywhere.)

Total cost of all parts NOW ONLY **42/6** P. & P. 3/-.
Parts price list and easy build plans 1/6.

ROAMER SIX *NEW!!*



★ 8 stages—6 transistors and 2 diodes. ★ 6 waveband.
★ Now with Philco micro-alloy R.F. transistors.
Listen to stations half a world away with this 6 waveband portable. Tunable on M. and L. waves. Trawler Band and three Short waves. Push-pull output. Sensitive ferrite rod aerial and telescopic aerial for short waves. Top grade transistors. 3-inch speaker, handsome case with gilt fittings. Size 7½ × 5½ × 1¾in. ★ Extra band for easier tuning of LUX. etc.

Total cost of all parts NOW ONLY **£3.19.6**
Parts price list and easy build plans 2/-. Carrying Strap 1/6 extra. P. & P. 3/6.

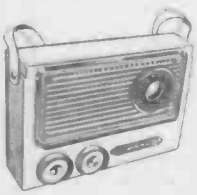
ROAMER SEVEN Mk. III

5 WAVEBAND PORTABLE OR CAR RADIO
AMAZING PERFORMANCE AND SPECIFICATION
★ *NOW WITH PHILCO MICRO-ALLOY R.F. TRANSISTORS.*
★ 9 stages—7 transistors and 2 diodes.

Covers M. and L. Waves, Trawler Band and two Short Waves to approx. 15 metres. Push-pull output for room-filling volume from rich toned heavy duty 'Celestion' speaker. Air spaced ganged tuning condenser. Ferrite rod aerial for M. & L. Waves and telescopic aerial for S. Waves. Real leather look case with gilt trim and shoulder and hand straps. Size 9 × 7 × 4in. approx. The perfect portable and the ideal car radio. (Uses PP7 battery available anywhere.)

Total cost of all parts NOW ONLY **£5.19.6.** P. & P. 5/6.
Parts price list and easy build plans 3/-.

SUPER SEVEN



★ 9 Stages 7 transistors and 2 diodes.
Covers M. and L. Waves and Trawler Bands. The ideal radio for home, car or can be fitted with carrying strap for outdoor use. Completely portable—built-in ferrite rod aerial for wonderful reception. Special circuit incorporating 2 RF stages, push-pull output, 3in. speaker (will drive larger speaker). Size 7½ × 5½ × 1¾in. (Uses 9v. battery, available anywhere.)

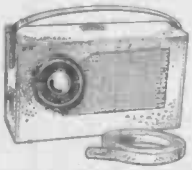
Total cost of all parts NOW ONLY **£3.19.6**
Parts price list and easy build plans 2/-. P. & P. 3/6.

NEW!! TRANSONA SIX

★ 8 stages 6 transistors and 2 diodes.
A top performance receiver covering full M. & L. Waves and Trawler Bands. Push-pull output. High-grade speaker makes listening a pleasure. Ferrite rod aerial. Many stations listed in one evening including Luxembourg loud and clear. Attractive case in grey with red grille. Size 6½ × 4½ × 1¾in. (Uses PP4 battery, available anywhere.)

Total cost of all parts **59/6** P. & P. 3/6.
Parts price list and easy build plans 2/-.

MELODY SIX *NEW!!*



★ 8 stages—6 transistors and 2 diodes. Our latest completely portable transistor radio covering M. and L. waves. Incorporates pre-tagged circuit board, 3in. heavy duty speaker, top grade transistors, volume control, tuning condenser, wave change slide switch, sensitive 6in. ferrite rod aerial. Push-pull output. Wonderful reception of B.B.C. Home and Light, 208, and many Continental stations. Handsome leather look pocket size case, only 6¾ × 3½ × 1¾in. approx. with gilt speaker grille and hand and shoulder straps.

Parts price list and easy build plans 2/-. Total cost of all parts **£3.9.6** P. & P. 3/-.

All components used in our receivers may be purchased separately if desired. Parts price lists and easy build plans available separately at prices stated.

OVERSEAS POST 10/-.

RADIO EXCHANGE

61, HIGH ST., BEDFORD. Phone: 2367

Callers side entrance Barratts Shoe Shop. Weekdays 9-5 p.m. Sats. 9-12.30.

New 209 Communication Receiver. Latest model 1-20 Mc/s. Input voltages 12.24 115 and 230. Complete with phones, aerial, etc. **£23.**

Earphones for 209 Receiver, 10/-.

Spare Valve Kits for 209 Receiver Mark II, containing 2xDF91, E.F.92, 2xDAF91, C.V.284 and DK91, 1 x 6 v. bulb, fuse and 12v. 4 pin Vibrator in useful metal box, £1.

2,000 Loudspeakers. 8in. by leading manufacturers in attractive cabinets. Useful as extension speakers, 12/6 each. 2 for 22/6.

Logic Units by Mullard, contains 2 transistors, type OC84, ferrite coils, resistances, condensers. **Brand new, 17/6.**

Timers by Chamberlain & Hookham 1-30 secs., **£4.**

2 K.V.A. Variacs. Type 100 by Claude Lyons. **Ex** equipment, **£9.**

Coil Winding Machines

Oscilloscopes, by Nagar, Mullard, etc.

Vacuum Pumps, by Edwards, type 1S50, **£12/10/-.** 2S50, **£20.**

New 200/220v. Crompton Parkinson, ¼ h.p. Motor, **£2/10/-.**

Oil Diffusion Pumps, by Edwards. Models 203 and 403, **£6.**

Counter Tubes, type G.S. 10/C/S, new, boxed, 15/-.

Spot Weld Heads, **£4/10/-.** Many types of transformers suitable for spot welding, also control units. Details on request.

Industrial Spot Welders, 1, 2, 4, 50 and 70 KVA. Details on request.

E.C.H. Unit, by Rediyon, 7 kw.

Electric Solder Pots, various sizes.

Stoving Ovens, 24 x 24 x 24in. by Creda & Barlow Whitney, £40 ea.

Fan Heater and Cool Air Circulator. Wall mounting 3 kw. Brand new by famous manufacturer. Usual price £9/9/-. **Our price only £4/19/6.**

M.A.C. LIMITED

Works: **TROY ROAD, MORLEY, NR. LEEDS.**
Phone 2334

Shop: **126, NORTH ST., LEEDS. Phone: 26026**

Telescopic Aerial Masts. Tubular Steel Copperised spray finish ring cam locking on each section provides for full or any height required. Suitable all fixings and base locations. Bottom section 1¼in. dia. 20ft. (4 sections). Closed 5ft. 9in. Weight 16lb 55/- ,carr. 5/-. 34ft. (6 sections) closed 6ft. 6in. Weight 20lb. 75/-, carr. 5/-.
Auto Transformers 3 KVA. 110/250 v. mounted in steel case with external hand voltage regulator. American surplus. Brand New **£12/10/-**, carr. 15/-.
AR88D Receivers. New complete with spare set of valves and headphones. **£75.** carr. and packing £2.
Siemens High Speed Relays. 50 ohm + 50 ohm type H96B **10/6** ea.; 500 ohm + 500 ohm type H96D **10/6** ea.; 1,700 ohm + 1700 ohm type H96D **14/6** ea.
Siemens Miniature Relays. Size 1¼ × 1 × ¾in. Res. 700 ohm consumption 18mA on 12 volts. 2 pole 2 way contacts, contact rating up to 2 amps., 100 v. 30 watts max., **6/-** ea. Heavy Duty Type 250 ohms 12-24 v. operation 48mA on 12 v. contacts at 10 amps. max. **7/6** ea.
Headphones Moving Coil. Finest quality with Ear Muffs for noise excluding, **12/6** ea., wired with moving coil mike, **17/6** ea. Type DLR5 bal. armature, **9/6.**
Blower Motors. Ideal for car heaters, etc. Ex R.A.F. equipment, 12-24 volt, D.C., **39/6.** also small type high speed will work from 4½-6-12 volt supply, **14/6** ea.
Small Geared Motors. Final speed 80 r.p.m. Working voltage 6-12 v. Overall size 4 × 2 × 2in. **15/-**, carr. 2/-.
Pressure Gauge. 2in. round Brass case 0-160lb.. **9/6** ea.
Tannoy Loud Hailers. 3 watt output. Enclosed in strong wooded case, with steel protection. **27/6** ea.
Carbon Hand Mike. with replaceable insert, **7/6** ea.
Miniature Plugs and Sockets. Jones type, 8 Way **3/6** pr., 12 Way **4/6** pr.
Transmitter, Type BC 625 Part of TR S.C.R. 522 Range 100-156 Mc/s. complete with all valves par 832, **21/-**, carr. 3/-.
Inverter Type 300. Input 28 v. D.C. Output 40 v. A.C. 1000 cyc. Single Ph. **£3/10/-**, carr. 5/-.
Motor Generator. Type 4B Input 28 v. D.C. Output 80 v. 2000 cycle 2 kw. 1 Ph. **£12,** carr. 15/-.
Belling Lee. 25 Way Chassis mounting Plugs and Sockets. 1¼in. × 1¼in. × 1in., **8/6** ea.
Aerial Change-Over Relay. D.P.C.O. Heavy silver contacts, American Munf. **12/6** ea
Post Office Relays. 3000 sers. 2CO; 2M; Coil Slugged 140 ohm. 2CO; 2M; 1,000 ohms 2CO; Coil Slugged 500 ohm. all at **6/-** ea. P. & P. 1/-.
Carpenters Type Relay 5HM52. 160 T. at 1.2 ohm; 3,000 T. at 150 ohm; 3,000 T. at 250 ohm, complete with securing springs and plug in base. **15/-** ea. P. & P. 1/-. G.E.C. type M1095 2M; 2B; 670 ohm, **7/6** ea.
807 Valves. **6/6** ea. P. & P. 1/-.
Signal Generator. Type 106 covers 5.5-55 Mega. complete in carrying case. Munf. Salford Instr. **£5/0/0.** Carr. 10/-.
Brand New Valve Voltmeters E 7555/2. Measuring range 0.1 to 15,000 D.C. or peak A.C. in seven ranges from .5 v. to 15,000 P.S.D. Power supplies: 110 to 120 v. and 200 to 245 A.C. complete with probe and instruction manual. **£17/0/0.** P. & P. 15/-.

Terms: CWO. *SAE enquiries*

SPECIAL OFFER
FIRE SALVAGE TRANSISTOR SETS
Long/medium wave coverage using 8 Sona transistors. Leather carrying case, 30/-.

B. S. RADIO AND ELECTRICAL STORE

108 CHESTER STREET, BIRKENHEAD, CHESHIRE.

PROOPS Walk-around Store
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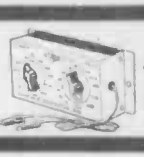
RESISTANCE SUBSTITUTION BOX



Two switched ranges providing instant selection of any of 24 accurately chosen resistors. Low range 15 ohms to 10 kilohms (1 watt rating). High 15 kilohms to 10 megohms (½-watt rating) 36in. red and black test leads with alligator clips. In totally enclosed attractively finished case size 4½in. × 2½in. × 1¾in.

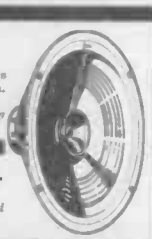
32/6 *Post & Pkg. 2/6*

CAPACITANCE SUBSTITUTION BOX

25/- *P. & P. 2/6*

Compact unit providing a directly switched accurate selection of 9 capacitors: 0.0001, 0.0022, 0.0047, 0.01, 0.022, 0.047, 0.1 and 0.22. Capacitance rating 600 v.w., case size 4½in. × 2½in. Fitted with 36in. red and black test leads with shrouded alligator clips.

12in. SPEAKER OFFER



High-quality, 12in. loudspeaker unit with built-in tweeter. Uses powerful high-flux magnet for wide frequency range reproduction. Input impedance, 3 ohms. Size overall: 12in. dia. × 5in. deep. Brand new, current production.

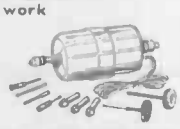
39/6 *Post & Packing 2/6*

HIGH VALUE RESISTORS 5 for 10/-

Glass encapsulated 125, 1,000 or 10,000 megohms. Tolerance 10%. One of each value Plus any chosen two. *Post paid*

MINIDRILLS

Precision tools for miniature electronic work



Superb miniature Electric Drill Kits offered at much less than half manufacturer's selling price. Designed to fit requirements of model and toy making, jewellery, dental, optical and camera repairing, radio and electronic building, miniature drilling and polishing. British manufacture but utilising the pick of world famous German and Japanese motors. Brand new in manufacturer's cartons and complete with 5 drilling, polishing and grinding tools and full instructions.

Type 6: Compact unit fitted with powerful motor and totally enclosed in white plastic casing. Size only 3½in. long × 1¼in. diameter overall. Complete with pin chuck, press switch and 5ft. connecting lead plus 5 tools. Works from any 4½-12 v. battery. 25/-. P. & P. 2/-. Type 8: Identical in appearance to Type 6, but fitted with more powerful motor and supplied with two additional chuck collets to accept larger size tool shanks. Works from any 4½-13½v. D.C. supply, 35/-. P. & P. 2/-. Kit for mains operated power pack 25/- extra.

SEMI-CONDUCTOR MODULES

Ice cube size encapsulated circuits

Solid state semi-conductor modules—fully transistorised and completely wired and tested circuits that only require a 6-volt battery and connection to input and output to provide a compact ready-made unit. Encapsulated, types are shockproof and almost indestructible. Supplied with instructions.

PUBLIC ADDRESS AMPLIFIER—needs only crystal microphone and any speaker. Frequency response designed to provide maximum intelligibility. With 15in. speaker sound covers hundreds of yards. Fully encapsulated. Size only 1¼in. × 1⅝in. × ¼in. 30/-. P. & P. 1/-.

METRONOME—requires only 2 megohm potentiometer and any P.M. speaker to produce accurate repetitive beats at adjustable rates from 40 to more than 208 beats per minute. Low battery drain: simple connections. 22/6. P. & P. 1/-.

CODE PRACTICE OSCILLATOR—Simply connect with morse key, any P.M. speaker and any 1½-6 v. battery. Fully transistorised and assembled on rigid board, size 2 × 1¼in. 12/6. P. & P. 1/-.

FIRE ALARM—Module contains temperature sensor and operates in conjunction with 8 ohm. loudspeaker and 2 megohm potentiometer. Increase of room temperature above preset level immediately triggers screaming syren alarm. 50/-. P. & P. 1/-.

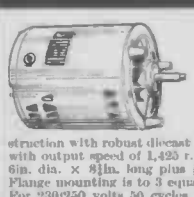
BURGLAR ALARM—Needs only 8 ohm. loudspeaker, switch and microswitch (or reed switch and magnet) to complete. Operation of sensing switch trigger upward screaming syren to give instant alarm. For home or motor car protection. 30/-. P. & P. 1/-.

6-12 volt BLOWER UNIT 25/- *P. & P. 2/6*

Self-contained assembly of compact, continuously rated motor and encased centrifugal fan. Smooth, silent running and providing a powerful blast of air from 1in. outlet pipe. Ideal for use with car heating and conditioning systems or to provide local cooling of hot running equipment and machinery. Operates from 6 volts D.C. (2 in series work on 12 volts) but can also be operated from 12 volts with 2 ohms 20 W resistor. Size overall: MOTOR, 2½in. diam. × 2½in. long; FAN 6½in. diam. × 1in. thick. In sparkling, unused condition.

FULL ½-H.P. MAINS MOTORS

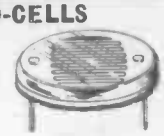
Continuously rated, silent running



Famous make Newman motors with fantastic starting torque and giving full ½-h.p. output. Can be readily installed for vertical or horizontal operation and will make an excellent drive unit for bench saws, compressors, potters wheels, lathes, planes, lawn mowers, and other light machinery. Heavy welded steel construction with robust diecast end frames and conforming to B.S.170. Smooth, silent operation with output speed of 1,425 r.p.m. automatically regulated by centrifugal switch. Size overall 6in. dia. × 8½in. long plus ¼in. dia. × 1¼in. long plain driving spindle with threaded end. Flange mounting is to 3 equally spaced lugs with mounting holes pitched on 5¼in. dia. circle. For 230-250 volts 50 cycles A.C. mains. Consumption 2½ amps. Excellent, never used condition. Fully guaranteed. Offered at a fraction of cost.

65/- *Carriage 7/6*

CADMIUM SULPHIDE PHOTO-CELLS



TYPE 1 **TYPE 2**

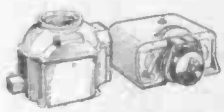
New, inexpensive photo-conductive cells which act as light-sensitive resistors that increase conductivity with increased light. These are 1,000 times more sensitive than selenium cells, with greater reliability and can easily be built into a wide range of simple circuits. Typical uses include automatic light controls for home and car, flashing barricade or breakdown lights, exposure meters, brightness controls, relay operation, and many other devices. Require only simple low power source from battery or mains transformer. Two types available.

Type 1.—Max. voltage 200 v. Output 0.5 W. **10/-** *post free*

Type 2.—Max. voltage 150 v. Output 0.15 W. **8/6** *post free*

Both types have a resistance range of 5 megohms at zero to 500 ohms at 1,000 lux. Sensitiv range is 400-800 mu. Supplied with specification; instructions and typical circuits.

D.C. GYRO AND SERVO MOTOR—C1



Beautifully engineered Minniapolis-Honeywell precision gyro, totally enclosed in sealed light-alloy housing about 8¼in. cube. Automatic erection and precession correction. Large diameter Desynn type transmitting potentiometers provide signals corresponding to the magnitude of the deviation of gimbal arms. Powerful D.C. servo motor coupled through a differential reduction gear to a 4in. spur driving gear integral with a 3in. diam. spiral groove cable driving drum. Two magnetic solenoid clutches and corresponding brakes hold drum rigidly in position or set free for "neutral." Nominally for 24-volt operation, but operates at 12 volts. Size 10in. × 6in. × 8in.

£10 each unit or £17/10/0 pair *Carriage 10/-.*

DRY REED SWITCHES

Basically a pair of gold diffused reed contacts hermetically sealed in a glass tube filled with inert gas. Contacts can be actuated by permanent, or electromagnets and so form ideal devices for a wonderful range of inexpensive devices such as burglar alarms, limit switches, position indicators, r.p.m. counters, night light controls, door bell switching, level controls, etc., etc. Reed switches have tremendous reliability factors and a working life of about 100 times that of micro-switches, and the use to which they can be put is limited only by imagination. Each switch is supplied complete with specification, instructions and ideas information.

Suitable magnets 1/- extra

7/- each, *post free.*

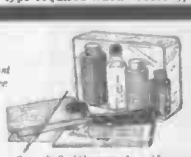
MINIATURE TYPE 8/6 *post free*

Only 0.82 inches long by 0.15 inches thick. Maximum current for long life, 100 milliamps.

REED SWITCH COILS 4/- *post free*

Specially manufactured to provide electro-magnetic operation of Dry Reed Switches. Coil is simply pushed over glass tube envelope of switch and located round switch contacts. Size overall: ¾in. dia. × ¾in. long. Two types are available: Type 1—operates from any D.C. voltage from 1½ to 6 volts; Type 2—operates from any D.C. voltage from 6 to 12 volts. Please state type required when ordering.

ETCH YOUR OWN PRINTED CIRCUIT KITS 21/- *post free*



Each contains over 60 sq. in. of laminated board and sufficient chemicals to make dozens of printed circuits, plus comprehensive instruction book giving advice and examples on translating theoretical circuits into layouts ready for etching. High quality materials—completely safe to handle—carefully prepared to ensure fine definition and uniform results without laboratory control.

HEAVY DUTY LEAD ACID BATTERIES

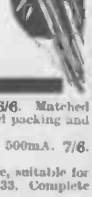
6 v. 170 AMP HOUR

Government Spec., quality construction. Genuine 6 v. 170 amp Hour Power Storage Batteries intended to ensure reliable operation in really tough conditions. Insulated battery case is actually moulded into tough but lightweight ribbed steel outer case with hinged lid to give all round protection. Unused, modern soft separator units, dry charged and carefully stored. Size overall: 15⅛in. × 7⅛in. × 13¼in. high. Fitted with hinged carrying handles. Charging and maintenance instructions in lid. **£4/10/0** Carr. 10/-.

6 v. 40 AMP. HOUR

Similar in construction and quality to above, size approx. 9in. × 4in. × 9in. high. Fitted with leather carrying strap. **£1/0/0** Carr. 5/-.

MINIATURE MAINS INDICATOR LIGHTS



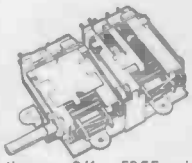
Give positive indication that equipment, tools, instruments, apparatus, etc., is switched on. Complete assembly of neon, resistor, insulation and flying leads that requires only connection to switch. Small size and insulation permit simple fitting; just drill small hole in panel or tape or clip to equipment. Current consumption negligible. New manufacture.

4 for 5/- *post free*

GUARANTEED TRANSISTORS. O.C.44 and O.C.45 2/6. O.C.71 3/6; O.C.26 6/6. Matched pairs of G.E.T. 8 (max. volts 32, output 50 w. in push-pull) 14/6 per pair. Add packing and postage.

SILICON RECTIFIERS. XU612 50 p.i.v. 500 mA. 2/6. R.T.C.D. 1,000 p.i.v. 500mA. 7/6. Silicon bridge 24 v. D.C. 6 A. full wave £2.

ADJUSTABLE POT CORE. Mullard Vinkor Type LA45 18 mm. adjustable core, suitable for frequency range 120 kc/s. 1.2 Mc/s. Effective permeability 25. Turns for 1 mH. 133. Complete and brand new, 4/6. P. & P. 1/.



CYLDON A.M./F.M. PERMEABILITY TUNER FOR ALL TRANSISTOR OPERATION

Size 2½in. x 2½in. approx. By famous manufacturer. A.M.-I.F. 470 Kc/s. F.M.-I.F. 10.7 Mc/s. A.M. coverage from 1,620 Kc/s-525 Kc/s. F.M. coverage 108 Mc/s.-88 Mc/s. Circuit diagram 2/6. FREE with Tuner. 1st, 2nd, 3rd A.M.-I.F.'s 1st, 2nd, 3rd and 4th F.M.-I.F.'s V.H.F. Osc. choke A.M.-F. trap. All the above are the R.F. end of an AM/FM receiver car radio, etc. The above items.

£2 . 10 . 0

BSR MONARCH UA14 With FUL-FI HEAD

4-speed, plays 10 records, 12in., 10in. or 7in. at 16, 33, 45 or 78 r..p.m. Intermixes 7in., 10in. and 12in. records of the same speed. Has manual play position: colour, brown. Dimensions: 12½ x 10½in. Space required above baseboard 4½in., below baseboard 2½in. Fitted with Ful-Fi-turnover crystal head, £5/19/6. P. & P. 6/6.

B.S.R. UA16, similar to the above, £6/12/6. P. & P. 6/6.

B.S.R. GU7, 4-speed, single player, complete with pick-up on uniplate with automatic switch £3/19/6. P. & P. 5/6.

FLUORESCENT LIGHT KIT

TWIN 20 CHOKE Instant start complete with 4 bi-pin 200/250 v. holders.

11/6 P. & P. 4/-

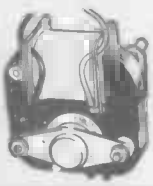
TWIN 40 CHOKE instant start with 4 bi-pin 200/250 v. holders.

17/6 P. & P. 4/-

50 v. D.C. Input. Output 240 v. A.C. 40 Watts incorporating transformers, choke, condensers and 2 Get 573. In solid 16 gauge Aluminium Case size 15in. x 6in. x 2½in. by famous manufacturer. **19/6** plus 6/- P. & P.

AC MAINS MOTOR

Can be used for a variety of purposes, silent running, satisfactory in every way, 230/250 v. A.C.



9/6 P.&P. 2/-

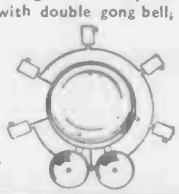
FLUORESCENT LIGHT FITTING

Twin 40 watt 200/250 v. less tubes. **39/6** P.&P. 6/-

RING BURGLAR ALARM

A.C. Mains 200/240 volt. Fire salvage slightly tarnished.

List price 7 gns. Our price complete with double gong bell, five micro switches and full instructions.



49/6

P. & P. 4/-

SILICON RECTIFIERS 250 v. P.I.V. 750 milli-amps. Six for 7/6d. post paid.

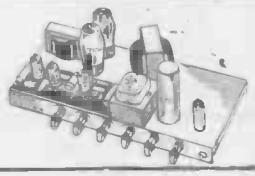
FIRST QUALITY PVC TAPE

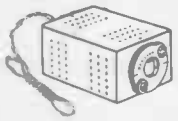
5⅞in. Std. 850ft.	9/-	5in. D.P. 850ft.	10/6
7in. Std. 1200ft.	11/6	3in. T.P. 600ft.	8/-
3in. L.P. 240ft.	4/-	5in. T.P. 1800ft.	20/6
5⅞in. L.P. 1200ft.	11/6	5⅞in. T.P. 2400ft.	27/6
7in. L.P. 1800ft.	18/6	7in. T.P. 3600ft.	37/6

P. & P. on each 1/6, 4 or more post free

6-VALVE 15 WATT PUSH-PULL AMPLIFIER

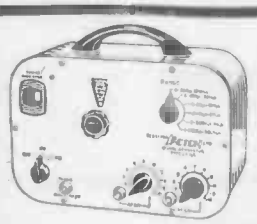
15 x 7 x 1½in. A.C. mains 200-250 volts. 4 inputs with controls for same and bass and treble lift controls. Tapped for 3 and 15 ohm speakers. Extra H.T. and L.T. for F.M. Tuner supplies, etc., built and tested, 7 gns. plus 12/6 P. & P.





POWER SUPPLY KIT

In metal case, size 3½in. x 2½in. x 2in. Incorporating mains transformer, rectifier and condensers. 230/250 A.C. Mains. Output: 9 v. 100 mA. Price 10/6 plus 2/6 P. & P.



SIGNAL GENERATOR

Covering 100 Kc/s.-100 M/cs. on fundamental and 100 Mc/s. to 200 Mc/s. on harmonics. Metal case 10in. x 6½in. x 5½in., grey hammer finish. Incorporating three miniature valves and metal rectifier, A.C. mains 200/250 v. Internal modulation of 400 c.p.s. to a depth of 30%. Modulated or unmodulated R.F. output continuously variable, 100 millivolts C.W. and mod. switch, variable A.F. output. Incorporating magic-eye as output indicator. Accuracy plus or minus 2%

£7/5/0 Post and packing 6/6 extra.

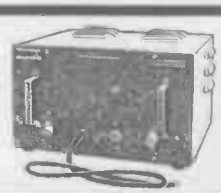
3 to 4 WATT AMPLIFIER KIT comprising chassis 8½in. x 2½in. x 1in. Double wound mains transformer, output transformer. Volume and tone controls, resistors, condensers, etc. 6V6 ECC81 and metal rectifier circuit 1/6 free with kit. 29/6 plus 1/- P. & P.

POCKET MULTI-METER. Sizes 3⅞ x 2½ x 1⅜in. Meter size 2½ x 1⅜in. Sensitivity 1,000 OPV on both A.C. and D.C. A.C. and D.C. volts 0-15, 0-150, 0-1,000. D.C. current 0-150 mA. Resistance 0-100KΩ. Complete with test prods, battery and full instructions. 39/6, Plus 1/6 P. & P.

50 MICRO-AMP. METER Movement by world-famous manufacturer. Size 3in. x 2½in. 25/- plus 1/6. P. & P.

FIXED FREQUENCY SIGNAL GENERATOR

Crystal control in metal case, size 10in. x 6in. x 6in. Incorporating 2 FC13 valves, mains transformer, metal rectifier, choke, indicator lamp, crystal and numerous components. Modulated and unmodulated output sockets. Originally used for I.T.V. frequencies. Brand new. 39/6 plus 6/- P. & P. A.C. Mains 200/250 volts.



SPECIAL OFFER—Power Supply Kit

To purchasers of "Elegant Seven" parts, incorporating mains transformer etc. AC mains 200/250 v outpnt 9 v 100 mA 7/6.

THE *"Elegant Seven"*

Combined Portable and Car Radio

- ★ 7-transistor superhet. Output 350 mW.
- ★ Two-tone grey wooden cabinet, fitted handle with silver-coloured fittings, size 12½in. x 8½in. x 3½in.
- ★ Horizontal tuning scale, size 11½in. x 2½in. silver with black lettering.
- ★ All stations clearly marked.
- ★ Ferrite-rod internal aerial.

The Radio with the "Star" Features

- ★ IF 460 kc/s.
- ★ Operated from PP9 battery.
- ★ Fully comprehensive instructions and point-to-point wiring diagram.
- ★ Printed circuit board, back-printed with all component values.
- ★ Fully tunable over medium and long waveband.
- ★ Car aerial socket.
- ★ Full after-sales service.

4in. **SPEAKER.** Parts list and circuit diagram 2/6. FREE with parts.

ONLY

£4.4.0

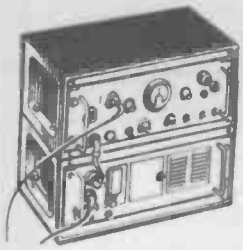
PLUS 5/6 POST & PACKING

RADIO AND T.V. COMPONENTS (ACTON) LTD.

21A, HIGH ST., ACTON, LONDON, W.3.

Goods not despatched outside U.K. All enquiries S.A.E. Terms C.W.O.

SHOP HOURS 9 a.m.--6 p.m. EARLY CLOSING WEDNESDAY



CARRIER FREQUENCY SHIFT ADAPTOR. This modern equipment of recent manufacture is in excellent condition and suitable for operation with most Service Receivers. IF frequency adjustable internally 445–475 kc/s, The adaptor will operate two independent Teleprinters. Power supplies A.C. mains 230 v. or 24 v. D.C. Price £12/10/-, Carr. 25/-.

RELAY UNIT. G.P.O. 600 types 5 relays 150 ohm 1 set C/O., and 5 relays 400 ohm 2 M., 1 set C/O., in metal box 8×6×5in., £2, post 5/-.
FACSIMILE KEYER UNIT KY 75 SRT, 115/230 volts, £25 each.
MODULATOR MD 168/UX (for the above keyer), £12/10/-.
SIGNAL GENERATOR 1-196A. Freq. range 100-156 mc/s. Power requirements 115 v. A.C. or batteries. £3 each. Carr. 15/-.
METERS. 0–60 amps., centre zero 6in. scale, proj. m/c., 17/6 each, 5/- post. 0–150 amps., centre zero 6in. scale, proj. m/c. (requires external shunt), 17/6 each, 5/- post. 0-100 amps., 6in. scale, A.C./D.C., 30/- each, 6/6 post. 90–180 v., A.C./D.C., 4in. scale, £1 each, 5/- post.
BC-221 or LM 13. Freq. meter complete with original charts in good working order. Range 125 kc/s.–20 Mc/s., £16/10/-, carr. 15/-.
SIGNAL GENERATORS
TF.144G. 230 v. A.C. 85 kc/s.–25 mc/s. In excellent condition, £16/10/- each, 25/- carr.
TS.12AP. Standing Wave Indicator Equipment. Complete with Amplifier and waveguide plumbing equipment, £12/10/- each, 15/- carr.
TS.36AP Power Meter, with accessories, used for checking radar outputs, £5 each, 10/- carr.
DE-ICER, Controller Mk. 3. Contains 10 relays D.P. changeover heavy duty contacts, 1 relay 4P, C/O. (235 ohms coil). Stud switch 30-way relay operated, one five-way ditto, D.C. timing motor with Chronometric governor 20–30 volts 12 R.P.M., geared to two 30-way stud switches and two Ledex solenoids, 1 delay relay, etc., sealed in steel case, size 4×5×7in., £3 each, post 5/-.
BC640 MODULATOR UNIT. 2×811's, mod. transformer and fil., trans. complete mod. unit fits 19in. rack 50 watts, £5/10/-, carr. £1.
GEARED MOTORS (Reversible).
20-30 v. D.C. 72 r.p.m., 17/6, post 2/6.
28 v. 150 r.p.m., 25/-, post 2/6.
24 v. Open gears with governor, approx. 10 r.p.m., 25/-, post 2/6.
24 v. D.C., 1.4 r.p.m., reversible with two micro switches inside gear box, silent operation, £2 each, post 5/-.

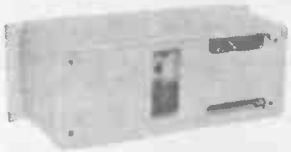
MARCONI V. LVE 1 VOLTMETERS TF428-B/1. Ranges: 0 to 1.5, 5, 15, 50 and 150 volts. Fitted with probe unit for RF measurements. 230 v. mains input. Brand new, £12/10/- each, carr. 10/-.

TCS MODULATION TRANSFORMER 20 w. Pri., 6,000 ohm C.T. Sec., 6,000 ohm. 25/- each, post 3/6. **MICROPHONE TRANSFORMER.** Pri., 75 ohm. Sec., 125,000 ohm. 10/- each, post 2/6.
OUTPUT TRANSFORMER. Pri., 7,500 ohm. Sec., 500 ohm. C.T., 2.5 w. 12/6 each, post 3/-.
POWER SUPPLY unit for SENDER No. 36, 110-240 v. A.C. input, contains Speech amplifier. Modulator and External power supplies, 3×FW4/500 rectifiers provide H.T. for F.R. unit Speech amplifier 6C5G, Modulator 2×6C5G and 2×807 output. Size 24×16×14 inches. Housed in a fine oak case with circuit. Weight 110 lbs. As new, £6/12/6, carr. 30/-.
CONVERTERS. Type 8 a., 24 v. D.C., 115 v. A.C. at 1.8 amps. 400 cycles, 3-phase. £5 each, carr. 7/6.
CONDENSERS. 1 mfd., 20 kv., £6/12/6 each, post 12/6 each. 0.25 mfd., 32,500 volts Wkg. £5 each, post 12/6 each. 150 mfd., 290 volts A.C. £5 each, post 12/6. 50 mfd., 330 volts A.C. 40/-, post 4/-. 10 mfd., 1,000 v. 12/6, post 2/6. 8 mfd., 1,500 volts, 17/6, post 2/-. 8 mfd., 1,200 volts, 12/6, post 3/-. 8 mfd., 600 volts, 8/6, post 2/6. 0.25 mfd., 2 kv. 4/-, post 1/6. Vacuum condenser 50 pf. 32 kv. 30/-, post 1/6. 6 pf. 20 kv. 22/6, post 1/6. All the above are new in cartons.
POWER FACTOR CONDENSERS. 160 mfd., 290 v. A.C. working. £5/10/- each, carr. 10/-.
4 mfd., 12,500 v. D.C. working, £7/10/- each, carr. 15/-.
BLOWER MOTORS. 24 v. D.C. (small U.S.A.), 12/6, post 2/-.
TELEPRINTERS. Type 7B, used, good condition. 24 v. D.C. £12/10/- each, carr. £1.
OSCILLOSCOPES, Cossor 1035 and 1049, used condition, £30 each. Hartley type 13A, £25 each. Solartron Type CT316, £20 each.
INVERTERS. Type AN3499, 28 v. D.C., 9.2 amps. input, 115 v. 400 c/s 3 phase, £5 each, post 5/-.
TX DRIVER UNIT. 100-156 Mc/s. Ideal for two meters, Valves 3C24, in excellent condition, fits 19in. rack, £5 each, carr. 20/-.

CONTROL UNIT. 230 v. A.C., output 24 v. 2 amps., 230 v. A.C. solenoid switch, 15 amps., plus relays and switches, etc., £2/10/-, carr. 12/6.
RECEIVERS. HRO. Used condition, less coils, £10 each, carr. £1. S.36, used condition, freq. 30-143 Mc/s. £25, carr. £2. S.27/U, used, freq. 143-210 Mc/s., £25, £2 carr. C.52, used, freq. 1.75-16 Mc/s., £5, carr. £1. H.63 (similar to 1392), 100-156 Mc/s., £5, carr. £1.

MARINE RADAR EQUIPMENT. Complete installation for 110/220 v., 3 cmm., made by B.T.H. Ltd. The equipment is mounted in a weatherproof steel van 6×6×6ft., with the scanner on top to rotate 360 deg. The units are available with service manuals and some spares. £500 each. F.O.B.

UNISELECTORS. 6 bank, 25 way, 20 ohm. coil, £2 each, post 2/6; 5 bank, 25 way, 20 ohm. coil, 35/- each, post 2/6. (Ex-new equipment.)
BOMB SELECTOR UNIT, complete with uniselector 3B., 25 watt; 22 ohms, magnetic counter 0-40, and 1 relay 500 ohm. 2 make, 50/- each; post 3/6.
HEADPHONES. DLR5, 10/- pair, 2/6 post. No. 10 headset and microphone, 15/-, post 2/6. M/C phones with chamois ear muffs and jack plug, 17/6 pair, post 2/6.



POWER AND SMOOTHING UNITS. 100-250 v., A.C. input 24 v., D.C. at 3 amps. or 12 v. twice at 3 amps., continuous rating, switched fused, etc. In metal case 19 × 7 × 7in. Smoothing two large chokes and 0-1 ma., meter scaled 0-50 volts. £7/10/- (pr.); 15/- carr.

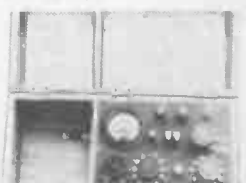
APX6 TRANSPONDER. Complete with UHF valves 2C42, 2C46 and 1B40, complete with special holders and condensers. 30 Valves, Blower Motor, Mechanical Counters, etc. 115 v. 400 c/s. (Suitable conversion for 1,200 Mc/s.). Price £10 each, carriage 15/-.
BATTERIES. Portable in metal case with carrying strap. 6 volt, 40 amps., new, unused, 20/-, carr. 6/6. Car type, 6 volt, 75 amps., £2, carr. 10/-.
RESISTORS. Variable. 3 ohm. 10 amps., 25/-, post 4/-.
ROTARY TRANSFORMERS. 24 v. input, 175 v. at 40 ma. output, 25/-, plus 2/- post. EICOR type, 12 v. input, 400 v. at 180 ma. output, 30/-, plus 4/- post. 12 v. input, 225 v. at 100 ma. output, 25/-, plus 3/- post. (All the above are D.C. only.)
MICROPHONE Type T50. Fits the palm of hand with on/off switch and lead (electro dynamic), 35/- each, plus 2/6.
CIRCUIT BREAKER. 150 amps. 600 v. A.C., £3 each, carr. 7/6.
PLUGS. Standard two-way jack plug PL55 with 6ft. lead and transformer, low to high impedance, 7/6 each, plus 1/6 post. PL68 plug and switch lead assembly, 5/- each, plus 1/6 post.
DIPOLE AERIAL. Complete set suitable for 60-100 Mc/s., 27/6, carr. 4/-.
COMPRESSOR UNIT. Aircraft cabin pressurisation unit, 28 v. D.C., with automatic switches, etc., £3/10/-, post 6/-.

AR88 SPARES. Set of 14 valves and headphones and 3 pilot lamps, new, original cartons, £3/10/- each, post 2/6. Set of 14 valves only, £2/10/-, post 2/-. Vibrator unit, 6 v., 15/-, post 4/-. Headset only, 12/6, post 2/-. Speaker unit, R.C.A., £3/10/-, plus 5/- post. Block condenser unit, 3×4 mfd. at 600 v., 25/- each, post 3/-. 0.01 mfd. 400 v. D.C., 4 for 12/6. Capacitor air trimmer, 2-20 pf., box of 3, 10/-.

1154 TRANSMITTER UNIT less power supplies (used), £4 each, plus 15/-.

TRANSFORMERS. 230 to 115 v., isolation 300 va., £3 each, plus 5/-. 230/115 auto 750 watts, £4, post 10/-. 230 v. pri., 1,850-0-1,850 at 500 ma., £5 each, plus 15/- carr. 230/115 auto 300 watts, £2, post 6/-. 230 v. pri., 24 v. at 2 amp., 22/6, post 5/-. 230/115 v. pri., 275-0-275 v. at 120 ma., 6.3 v. at 4 amp., 6.3 v. at 1 amp., 25/-, post 5/-.

RADAR RECEIVER APG501. Complete Unit with Blower Motor, 40 valves, Relays, Transformers, etc. Condition as new. Price £5 each, carriage 15/-.



WHEATSTONE BRIDGE in a beautiful oak case, centre zero galvanometer 2.5 mA., 4 stud switches, 0-10, 0-100 ohms, 0-inf., size 16×7¼×6in., 45/- each, 5/- post.

RADAR TRANSMITTER APG501. Complete Unit in pressurised case with Magnetron CBPV6765 and Klystron 6378 and associated crystals and waveguides, Blower Motor and 12 valves. Power inputs 115 v. 400 c/s. Condition as new, price £10 each, carriage 15/-.

FOR EXPORT ONLY
TRANS./REC. WIRELESS SET No. 31, complete sets with aerials, headphones and mikes in working order. Freq. 30/40 Mc/s. 4 channel xtal-controlled, £8/10/- each. **WIRELESS SET No. 88.** 4 channel, xtal-controlled, complete with all valves and xtals and attachments, £10 each. **WIRELESS SET No. C52.** 12 v. D.C. 1.7-16 Mc/s. on three bands, 110 watts output. CW, MCW, etc. Can be used as Vehicle T/R, or base station (as new complete set £52).

Complete Installations can be quoted for. Please write further details. List available 6d. S.A.E. for all enquiries.

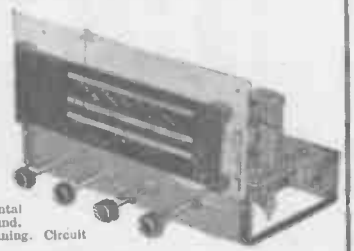
W. MILLS

3-B TRULOCK ROAD, TOTTENHAM, N.17
Phone: Tottenham 9213 & 9330

7 VALVE AM/FM RADIOGRAM CHASSIS

New 1965 Model now available!

Valves: ECC85, ECH81, EF89, EABC80, EL84, EM81, EZ80.



Three Waveband and Switched Gram positions. Med. 200-550 m. Long. 1,000-2,000 m. VHF/FM 88-95 Mc/s. Phillips permeability tuning insert on FM and combined AM/FM IF transformers. Latest circuitry including AVC and Neg. Feedback. Three watt output. Sensitivity and reproduction of a very high standard. Chassis size 13¼ × 6¼in. Height 7¼in. Edge illuminated glass dial 11¼ × 3¼in. Vertical pointer. Horizontal station names. Gold on brown background. A.C. 200/250 v. operation. Magic-eye tuning. Circuit diagram now available.

Aligned and tested ready for use **£13 . 19 . 6** *Carr. & Ins. 7/6*

Complete with Tape output socket, Ext. Speaker and P/U sockets & indoor FM aerial and 4 Knobs—walnut or ivory to choice.
3 ohm P.M. Speaker only required. Recommended Quality Speakers 10in. Rola 27/6. 12in. R.A. 30/-. 12in. R.A. with Tweeter, 42/6. E.M.I. 13¼ × 8in., 37/6. Carr. 2/6.

We manufacture all types Radio Mains, Transf. chokes, Quality O/P. Trans., etc. Enquiries invited for specials, prototypes for small production runs. Quotation by return.

RECORDING TAPE

Famous American Columbia (CBS) Premier quality tape at NEW REDUCED PRICES. A genuine recommended Quality Tape—TRY IT Brand new, boxed and fully guaranteed. Fitted with leader and stop foils.

	Standard		Double Play
5in.	600ft. 13/-	1,200ft.	31/6
5½in.	900ft. 16/-	1,800ft.	37/6
7in.	1,200ft. 21/-	2,400ft.	47/6
	Long Play		Post & Pack per
5in.	900ft. 17/6	reel, 1/- plus 6d.	
5½in.	1,200ft. 19/6	ea. for additional	
7in.	1,800ft. 28/6	reels.	

SPECIAL OFFER. 3in. Message tape 150ft. 3/9. 3in. L.P., 225ft. 4/9; 3in. D.P. 300ft. 6/6; P. & P. per reel 6d.
TAPE REELS. Mints.' surplus 7in. 2/3; 5½in. 2/-; 5in. 2/-; 3in. 1/3; Plastic spool containers, 5in. 1/9; 5½in. 2/-; 7in. 2/3.

SPEAKERS P.M. 3 ohms. 2½in. EMI, 15/6. 3in. Goodmans 16/6. 5in. Rola 15/6. 6in. Elac 16/6. 7 × 4in. Goodmans 15/6. 8in. Rola 19/6. 10in. Elac 25/-. 10 × 6in. Goodmans 22/6. 2½in. E.M.I. Tweeter, 22/6. 13¼in. × 8in. E.M.I. (Ceramic Magnet), 37/6.

ENAMELLED COPPER WIRE—½lb. reels 14g-20g 3/-; 22g-28g. 3/6; 30g-34g, 4/3, 30g-38g. 4/9; 39g-40g, 5/-, etc.

TINNED COPPER WIRE 16-22g, 3/ ½lb.

VALVE HOLDERS—Int. Oct. 6d. Nylon or Ceramic, B7G, B9A unskirted, 9d. B7G B9A skirted 1/- each; B7G with Can 1/6; B9A with Can, 1/9, etc.

KNOBS—Modern Continental types:—Brown or Ivory with Gold Ring. 1in. dia. 9d. ea. 1½in. 1/- ea. Brown or Ivory with Gold Centre, 1in. dia. 10d; each; 1½in. 1/3 each. LARGE SELECTION AVAILABLE.

JACK PLUGS—2½in. type 2/6; Screened ditto, 3/3; Stereo ditto, 3/6; 1½in. Screened 2/3; Transistor type Min. and Sub.-min. 1/3.

JACK SOCKETS—Moulded type, open 3/6; ditto, closed 4/-. Stereo ditto, 3/6; Paxolin type open 2/6; ditto, closed 3/-. Transistor type, closed, Min. and Sub.-min. 1/6.

PHONO PLUGS 9d. Phono Sockets (open), 9d. Ditto (closed), 1/-. Twin Phono Sockets (open), 1/3.

TYGAN FRET (Contem. pat.) 12 × 12in. 2/-; 12 × 18in. 3/-; 12 × 24in. 4/-, etc.
BONDACOUST Speaker Cabinet Acoustic Wadding, approx. 1in. thick. 18in. wide, any length cut 2/3 ft. 6/- yd. EXPANDED ANODIZED METAL. Attractive gilt finish. ¼ × ¼in. diamond mesh 4/6 sq. ft. Multiples of 6in. cut. Max. size 4ft. × 3ft. 47/6 plus carr.

JASON F.M. TUNER UNITS
Designer-approved kits available.
FMT1. 5 gns. 4 valves 20/-.
FMT2. £7. 5 valves 35/-.
JTV Mercury, 10 gns. 3 valves 22/6.
JTV2. £13/19/6. 4 valves 28/6.
NEW JASON F.M. HANDBOOK 2/6.
48 hr. Alignment Services, 7/6 plus 2/6.

CONDENSERS—Silver Mica. All values, 2 pf. to 1,000 pf., 6d. each. Ditto ceramics 9d. Tub. 450 v. T.C.C., etc. .001 mfd., .01 and .1/350 v. 9d. .02-1/500 v., 1/-. .25 Hunts 1/6. .5 T.C.C. 1/9 etc., etc.
CLOSE TOL. S MICAS. 10%, 5 pf.-500 pf. 8d. 600-5,000 pf. 1/-. 1% 2 pf.-100 pf. 9d. 100 pf.-500 pf. 11d. 575 pf.-5,000 pf. 1/6.

RESISTORS—Modern ratings full range 10 ohms to 10 megohms. 20% ½-½ w. 3d. ea., ditto 1 w. 6d. ea., 2 w. 9d. ea., 10% ½-1 w. 4d. ea., 5% Hi-stab. ½-½ w. 6d. ea. (below 100 ohms and over 1 meg. 9d. ea.). 1% Hi-stab., ½ w. 1/6 ea. (below 100 ohms 2/- ea.).
WIREWOUND, 25 ohms to 10K, 5 w. 1/3. 10 w. 1/6. 15 w. 2/-.
PRE-SET T.V POTS. W.W. 25 ohms-50K, 3/-. 50 K. 2 Meg. (Carbon), 3/-.

Electrolytics All Types New Stock

TUBULAR		CAN TYPES	
25/25v. 50/12v.	1/9	8+8/450 v.	4/6
50/50v. 100/25v.	2/-	32+32/275v.	4/6
8/450v. 4/350v.	2/3	50+50/350v.	6/6
16/80/450 v.	5/6	60+250/275v.	17/6
32/32/450 v.	6/6	100+300/275v.	12/6

Transistor Midget types—all values 1 mfd. to 56 mfd. 1/9 ea. 100 mfd. 2/-, 12 v.

VOLUME CONTROLS—5K—2 Meg. ohms, 3in. SPINDLES, MORGANITE MIDGET TYPE. 1½in. dia. Guar. 1 year. LOG or LIN, ratios, less 8w. 3/-. D.P. 8w. 4/6. Twin Stereo less 8w. 6/6. Some values with DP 8w. 8/6.

SOLDERING IRONS. Mains 200/220 v. or 230/250 v. Solon 25 watt Inst., 22/6. Spare Elements, 5/6. Bits, 1/3. 65 watt, 27/6, etc.

ALUMIN. CHASSIS. 18g. Plain Undrilled, folded 4 sides, 2in. deep, 6in. × 4in., 4/6; 8in. × 6in., 5/9; 10in. × 7in., 6/9; 12in. × 6in., 7/6; 12in. × 8in., 8/-, etc.

ALUMIN. SHEET. 18g. 6in. × 6in., 1/-; 6in. × 9in., 1/6; 6in. × 12in., 2/-; 12in. × 12in., 4/6, etc.

6 VALVE AM-FM TUNER UNIT

Med. and VHF 190 m.-550 m., 85 Mc/s.-103 Mc/s., 6 valves and metal rectifier. Self-contained power unit, A.C. 200/250 v. operation. Magic-eye indicator, 3 push-button controls, on/off, Med., VHF. Diode and high output sockets with gain control. Illuminated 2-col. perspex dial 11¼ × 4in. Chassis size 11¼ × 4 × 5¼in. A recommended Fidelity Unit for use with Mullard "3-3" or "5-10" Amplifiers. Available only at present as built-up units, aligned and tested ready for use. Bargain Price £12/10/-. Carr. 5/-. This popular unit will be available in kit form within the next few weeks. Circuit and Construction details 2/6.

Only a few items are listed from our comprehensive stock. Write now for full bargain lists, 3d.

Terms: C.W.O. or C.O.D. post and packing ½lb. 9d., 1lb. 1/3, 3lb. 2/3, 5lb. 2/9, 10lb. 3/9, etc.

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Tel.: THO 2188. Hours 9 a.m.—6 p.m. 1 p.m. Wednesday

BENTLEY ACOUSTIC CORPORATION LTD.

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THE VALVE SPECIALISTS *Telephone PRIMROSE 9090*
ALL GOODS LISTED BELOW IN STOCK

OA2	4/6	7H7	5/9	DF97	10/-	EM71	15/6	QV04/7	7/-	MIDGET	
OB2	6/-	7R7	12/6	DH76	3/6	EM80	6/3	R10	15/-	SILICON	
OZ4GT	4/3	7Y4	5/-	DK40	15/6	EM81	7/-	R16	29/-	RECTI-	
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1A7GT	7/9	10C1	8/9	DK96	6/6	EM85	8/9	R19	6/6	Mullard	
1C5	5/-	10C2	12/3	DL68	15/-	EM87	7/6	8P41	2/-	BY100	
1D6	9/6	10D2	11/8	DL96	6/-	EN31	10/-	8P61	2/-	Output	
1H5GT	7/9	10F1	10/-	DL810	10/6	EY51	5/9	8U25	27/2	250 v. at ½	
1L4	2/3	10F9	9/9	DM70	5/-	EY81	7/3	T41	9/-	amp.	
1LD5	4/-	10F18	9/9	DY86	6/9	EY83	9/3	TDD4	7/6	No larger	
1LN5	4/6	10P13	8/3	DY87	8/-	EY84	9/6	TH41	10/-	than a shirt	
1N5GT	8/6	10P14	11/6	E80F	24/-	EY86	5/9	TH233	6/9	button	
1R5	4/-	12A6	2/3	E83F	24/-	EY88	8/9	TP22	5/-	7/- each.	
1S4	5/-	12AC6	8/8	E88CC	10/-	EZ40	5/3	TP25	5/-	TRAN-	
1S5	3/6	12AD6	9/6	E180F	19/6	EZ41	6/3	TP2620	7/6	SISTORS	
1T4	2/3	12AE6	8/-	EA50	1/6	EZ80	3/9	TY86F	11/8	AND	
1U4	5/6	12AH8	10/9	EA76	6/9	EZ81	4/6	U12/14	7/6	DIODES	
1U5	5/3	12AT6	4/6	EABC80	5/9	FC4	8/9	U16	15/-	AA129	4/6
2D21	5/6	12AU6	5/9	EAC91	3/3	GZ33	17/6	U18/20	6/6	AC107	14/6
2X2	3/-	12AV6	6/6	EAF42	7/6	GZ34	10/-	U19	48/6	AC127	9/6
3A4	3/9	12BA6	5/9	EB34	1/-	GZ37	14/6	U22	5/9	AD140	25/-
3A5	6/9	12BE6	4/9	EB41	4/9	HABC80	9/3	U24	12/6	AF102	27/6
3B7	5/-	12BH7	6/-	EB91	2/3	HL41DD		U25	8/6	AF114	11/-
3D6	3/9	12K1	16/9	EBC33	6/-		12/-	U26	7/6	AF115	10/6
3Q4	5/3	12J7GT	7/3	EBC41	6/6	HL42DD		U31	7/-	AF116	10/-
3Q5GT	7/-	12K5	10/-	EBC81	5/9		12/-	U33	13/6	AF117	5/6
3S4	4/6	12K7GT	3/6	EBF80	5/9	HN309	25/-	U35	16/6	AF118	20/-
3V4	5/3	12K8GT	9/-	EBF89	7/3	HVR2	8/3	U37	29/-	AF124	11/-
5R4GY	8/6	12Q7GT	3/6	EBF89	6/-	HVR2A	8/9	U45	15/6	AF125	10/6
5U4G	4/6	12SA7	6/9	EBL21	10/6	KT33C	4/-	U76	4/6	AF126	10/-
5Y4G	8/-	12SC7	4/-	EC92	6/6	KT36	29/1	U101	19/6	AF127	9/6
5Y3	4/9	12SK7	3/-	ECC32	4/-	KT41	7/6	U191	9/6	BYZ13	11/6
5Z3	6/6	12SQ7	3/-	ECC33	29/1	KT44	5/-	U281	8/9	MAT100	7/9
5Z4G	7/6	14H7	9/6	ECC34	21/7	KT61	6/9	U282	12/3	MAT101	8/6
6A8	5/9	19AQ5	7/3	ECC35	5/3	KT63	3/9	U301	11/6	MAT120	7/9
6AG5	2/6	19H1	6/-	ECC40	7/-	KT66	12/3	U329	9/-	MAT121	8/6
6AG7	5/9	20D1	10/-	ECC81	3/6	KT88	28/-	U403	9/9	OA5	6/-
6AK5	4/9	20D2	21/-	ECC82	4/6	KTW61	4/9	U404	6/-	OA10	6/6
6AQ5	5/9	20P2	11/6	ECC83	4/6	KYW62	5/6	U801	16/3	OA70	3/-
6AT6	3/9	20L1	12/6	ECC84	5/6	KTW63	5/6	U4020	6/6	OA73	3/-
6AU6	5/3	20P1	12/6	ECC85	5/9	MHLD6	12/6	UABC80	5/-	OA79	3/-
6AV6	5/6	20P3	12/-	ECC88	8/9	MU14	4/6	UAF42	7/-	OA81	3/-
6B8G	2/6	20P4	13/8	ECC189	11/6	N37	10/6	UB41	10/6	OA85	3/-
6BA6	4/6	20P5	12/6	ECC807	15/-	N78	26/-	UBC41	6/3	OA86	4/-
6BE6	4/9	25A6G	7/6	ECF80	6/6	N108	26/2	UBC81	6/3	OA90	3/-
6BG6G	13/6	25L6	4/9	ECF82	6/3	N339	15/-	UBF80	5/9	OA91	3/-
6BH6	5/3	25Z4G	7/-	ECF86	11/6	PABC80	6/9	UBF89	6/9	OA95	3/6
6BJ6	5/6	25Z5	7/3	ECF804	24/-	PC86	10/3	UBL21	10/9	OA210	9/6
6BQ7A	7/6	27SU	23/3	ECH21	9/-	PC88	9/6	UC92	6/3	OA211	13/6
6BR7	9/-	27SU	9/9	ECH35	6/3	PC95	6/9	UCC84	8/9	OC16	35/-
6BR8	8/-	30C1	6/6	ECH42	8/-	PC97	6/9	UCC85	6/6	OC19	25/-
6B87	25/-	30C18	10/6	ECH81	5/9	PCC84	5/6	UCF80	8/9	OC22	23/-
6BW6	8/9	30P5	5/9	ECH83	6/6	PCC85	6/9	UCH21	8/-	OC23	57/-
6BW7	5/-	30L1	5/6	ECH84	9/6	PCC88	10/6	UCH42	8/-	OC25	12/-
6C5	4/-	30L15	9/3	ECL80	6/-	PCC89	8/6	UCH81	6/6	OC26	8/-
6CD6G	18/-	30P4	12/3	ECL82	6/6	PCC189	10/6	UCL82	7/9	OC28	23/-
6CH6	5/-	30P12	7/6	ECL83	9/6	PCF80	6/6	UCL83	9/-	OC29	16/6
6CW4	24/-	30P19	12/3	ECL86	8/9	PCF82	6/3	UF41	6/9	OC35	9/6
6D3	9/6	30PL1	9/6	EF9	20/6	PCF84	8/6	UF42	4/9	OC36	21/6
6E5	9/6	30PL14	12/6	EF22	6/6	PCF86	7/9	UF80	6/3	OC41	8/-
6F1	9/6	35A5	20/9	EF36	3/3	PCF801	10/-	UF85	6/9	OC42	5/-
6F6G	3/9	35L6GT	6/-	EF37A	6/-	PCF802	10/-	UF86	9/-	OC43	12/6
6F13	3/9	35W4	4/9	EF40	8/9	PCL82	6/6	UF89	6/-	OC44	4/9
6F23	6/3	35Z3	16/2	EF41	6/9	PCL83	9/6	UL41	7/3	OCC44PM	
6F24	9/6	35Z4GT	4/6	EF42	3/9	PCL84	7/6	UL44	23/3		11/-
6F33	3/6	35Z5GT	5/9	EF50	2/6	PCL85	7/6	UL46	8/6	OC45	4/9
6J5G	3/-	50B5	6/6	EF54	3/-	PCL86	8/9	UL84	6/-	OC45M	8/-
6J6	3/-	50C5	6/6	EF73	5/-	PEN45	7/-	UM4	15/2	OC65	22/6
6J7G	4/6	50CD6G	40/8	EF80	4/-	PEN45DD		UM34	16/10	OC66	25/-
6K7G	1/3	50L6GT	6/3	EF83	9/9		12/-	UM80	8/3	OC70	6/8
6K8G	3/3	72	6/6	EF85	4/6	PEN383	10/3	UR1C	6/6	OC71	6/6
6K8GTM	8/6	78	4/9	EF86	6/6	PEN453DD		UU6	11/-	OC72	8/-
6K25	24/-	80	5/3	EF89	4/-		10/-	UU8	11/6	OC73	16/-
6L1	10/-	85A2	6/6	EF91	3/-	PEN DD		UY1N	10/3	OC74	8/-
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6L7GTM	5/6	90AV	67/8	EF97	10/-	PL33	9/-	UY41	5/-	OC76	8/6
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6V6G	3/9	BL63	10/6	EL42	7/6	PY32	8/9	W76	3/6	OC170	8/6
6V6GT	5/6	CCH35	12/6	EL81	8/3	PY33	8/9	W81M	5/9	OC171	9/-
6X4	3/9	CV85	14/6	EL83	6/9	PY80	5/-	X41	10/-	OC200	10/6
6X5	4/6	CY31	5/9	EL84	4/6	PY81	5/-	X61	6/3	OC202	29/-
6/30L2	9/-	D15	13/6	EL85	7/6	PY82	4/9	X65	5/6	OC203	24/6
7A7	12/6	D43	17/9	EL86	7/3	PY83	5/9	X66	7/3	OC203	14/-
7B6	12/6	DAF96	6/-	EL91	2/6	PY88	7/3	X76M	9/-	OCP71	17/6
7B7	9/6	DF4	12/6	EL95	5/6	PY800	6/-	X78	20/6	ORP12	12/6
7C5	8/-	DD41	10/6	ELL80	13/6	PY801	6/3	X79	27/-	T82	12/6
7C6	6/9	DF96	15/-	EM4	17/9	QQV03/10		Y63	5/-	T83	15/-
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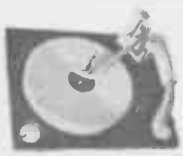

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BRAUN PC4L Stereo	£12	9	6	GARRARD SRP10 latest model single player with G.C.8.	£5 9 11
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Model B	£25	4	0		

All other current models available. Postage on all above 5/- extra.

FEW ONLY E.M.I. 4-SPEED SINGLE RECORD PLAYER

Fitted with lightweight pick-up with ÁCOS G.P. 73/2 stereo cartridge. Cabinet space required 13¼ × 12½ × 4¼in. 9in. metal turntable with Auto-stop. For 200/250 volt A.C. Mains. The stereo cartridge will play all types of Mono Records, 78s, L.P.s, etc.

LASKY'S PRICE 79/6 Post 3/6.

TAPE RECORDERS

REFLECTOGRAPH MODEL A

SEMI-PROFESSIONAL TAPE RECORDER

These recorders are new and guaranteed in the maker's original cartons. They represent an excellent opportunity for the professional and the quality conscious amateur to acquire the best at almost half price. Brief specifications: Frequency response 35 to 15,000 c/s at 7½ i.p.s.; two speeds—7½ and 3¾ i.p.s.; 3 motors; 8½in. reel capacity; record level meter; separate record and playback volume controls; bass and treble controls; fast forward and rewind; built-in 8 × 6in. speaker with extension L.S. socket; monitoring facilities provided through the internal speaker; outlet from pre-amplifier for extra amplification; for 200/250 v. 50 c.p.s. mains use; tape position indicator fitted; inputs for microphone and radio/pick-up. The recorder is finished in grey and is mounted in free-standing mahogany plinth—size: 20 × 16 × 9in.

LASKY'S PRICE 69 Gns. (List price of this Recorder is £110/5/-.) Carriage and Insurance 30/- extra.

FEW ONLY—Carrying Cases for the Reflectograph. **LASKY'S PRICE 6¾ Gns.** Post 5/-.

OPTIONAL EXTRA—PAMPHONIC VR 53 STUDIO RIBBON MICROPHONE

For use with the Reflectograph Model A Recorder. High quality Ribbon Microphone. New and unused in maker's original packing. Low impedance. Listed at £9/19/6.

LASKY'S PRICE £4.19.6 Post 2/6. Post free if ordered with the Reflectograph Recorder.

HIGH QUALITY TAPE RECORDERS

Complete with crystal microphone, reel of tape and empty spool. General specification: Tone Control; Visual Recording Indicator; Inputs; Microphone; Radio; Record-Player; Telephone Adaptor; Automatic Erase; Fast forward and reverse; 3 ohm speaker with extension socket; Carrying Case with detachable lid. Size for Models A and B: 14½ × 14 × 6½in. Size for Models C and D: 14 × 12½ × 6½in.

MODEL A Fitted with Collaro ¼-track Studio Deck. Speeds 1⅞, 3¾ and 7½ i.p.s. Spool capacity 7in. Playing Times: up to 18 hours. Frequency Response: 12,000 c.p.s. at 7½ i.p.s. Mains Voltage 200-250 v. 50 c/s A.C. Output 3 watts.

LASKY'S PRICE 27 Gns. Carriage and Insurance 15/- extra.

MODEL B Fitted with Collaro ¼-track Studio Deck. Specification as for Four Track model above. Maximum Playing Time: up to 9 hours from one reel of tape.

LASKY'S PRICE 25 Gns. Carriage and Insurance 15/- extra.

MODEL C Fitted with B.S.R. ¼-track Deck. Specification: Single speed, 3¾ i.p.s. Freq. response 10,000 c.p.s. at 3¾ i.p.s. Spool capacity: 5½in. Mains voltage 200-250 v. 50/60 c/s A.C. Output: 3 watts. Playing time up to 3 hours.

LASKY'S PRICE 18 Gns. Carriage and Insurance 15/- extra.

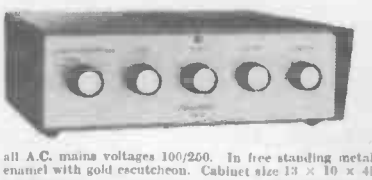
MODEL D Fitted with B.S.R. ¼-track Deck—otherwise same specification as the Model C—but maximum playing time increased up to 6 hours.

LASKY'S PRICE 21 Gns. Carriage and Insurance 15/- extra.

H.P. Terms are available on the above models.

AMPLIFIERS

PAMPHONIC TYPE 1004 AMPLIFIERS



A 10-watt integrated mono amplifier with inputs for Radio, Tape, Mic. and pick-up. Frequency response 20 c/s to 30 Kc/s. Three different equalising settings for pick-up. Volume, bass and treble controls fitted, also variable contour (slope) control. Output socket for tape recorder fitted. Extra H.T. and L.T. provided for auxiliary equipment. Output impedance 3 and 15 ohms. For all A.C. mains voltages 100/260. In free standing metal cabinet finished in brown hammer enamel with gold escutcheon. Cabinet size 13 × 10 × 4in. List Price 25 Gns.

LASKY'S *SPECIAL OFFER* PRICE 12 Gns. Carr. & Pack. 10/6.

A Merchandise Credit Note for 3 Gns. will be given to customers who purchased this amplifier from us at our previous price of 15 Gns on production of proof of purchase to Head Office.

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Model 227M	£36	15	0	T.4.b	£20	8	0
Model 223	£28	15	0	127M	£26	10	0
Stereo 55	£29	18	0	127	£27	10	0
Model 227	£52	15	0	S.T.3. Mk. II	£25	12	0
Model 226	£61	0	0	A.20 Stereo Amp.	£23	12	6
Model 222 Amp.	£27	10	0	P.C.U. 25 Stereo Pre-amp.	£21	0	0
Model 224	£22	10	0	Optional cases	£3	10	0

Stereo Multiplex Decoder now in stock £14 10 0 H.P. Terms available.

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TRANSISTOR PORTABLES

THE SKYROVER AND SKYROVER DE LUXE

GENERAL SPECIFICATION
7 transistor plus 2 diode superhet, 6-waveband portable receiver.
The SKYROVER and SKYROVER DE LUXE cover the full Medium Waveband and Short Waveband 31-49M., and also 4 separate switched band-spread ranges, 13M., 16M., 19M., and 25M., with Band Spread Tuning, for accurate Station Selection. The coil pack, and tuning heart is completely factory assembled, wired and tested. The remaining assembly can be completed in under three hours from our easy to follow, stage by stage instructions. Superhet, 470 Kc/s. All Mullard Transistors and Diode. Uses 4 U2 batteries. 5in. Ceramic Magnet P.M. Speaker. Easy to read Dial Scale, 500 MW Output. Telescopic Aerial and Ferrite Rod Aerial.

NEW! SKYROVER MK. III (Illustrated). Now supplied with redesigned plastic cabinet, finished in black and grey with chrome trim, edgewise controls. Controls: Waveband Selector, Volume Control with on/off switch, Tuning Control. In plastic cabinet, size 10 × 6¼ × 3¼in. with metal trim and carrying handle.

Can now be built for	Post	H.P. Terms: £1 deposit and	Total H.P.P.
£8.19.6	5/- extra.	11 monthly payments of 16/6	£10/1/6

The SKYROVER De Luxe Tone Circuit is incorporated, with separate Tone Control in addition to Volume Control, Tuning Control and Waveband Selector. In a wood cabinet, size 11¼ × 6¼ × 3in. covered with a washable material, with plastic trim and carrying handle. Also car aerial socket fitted.

Can now be built for	Post 5/- extra.	H.P. Terms: 25/- deposit and	Total H.P.P.
£10.19.6		11 monthly payments of 20/-.	£12/5/-

Data for each receiver: 2/6 extra. Refunded if you purchase the parcel. Four U2 batteries 3/4 extra. All components available separately.

★ **LONG WAVEBAND COVERAGE IS NOW AVAILABLE FOR THE SKYROVER & SKYROVER DE LUXE** A simple additional circuit provides coverage of the 1100/1950 M. band (including 1500 M. Light programme). This is in addition to all existing Medium and Short wavebands. All necessary components with construction data. Only **10/-** extra. Post Free.

This conversion is suitable for Skyrover and Skyrover De Luxe receivers already constructed.

REALISTIC SEVEN

Fully tunable, over long and medium wavebands. Uses 7 Mullard Transistors; plus Diode OA70.

STAR features:
★ 7 Transistor Superhet. ★ 350 Milliwatt output 4in. high flux speaker. ★ All components mounted on a single printed circuit board, size 5¼in. × 5¼in., in one complete assembly. ★ Plastic cabinet, with carrying handle, size 7in. × 10in. × 3¼in. in blue grey. ★ Easy to read dial. ★ External socket for car aerial. ★ I.F. frequency 470 Kc/s. ★ Ferrite rod internal aerial. ★ Operates from PP9 or similar battery. ★ Full comprehensive data supplied with each receiver. ★ All coils and I.F.s, etc., fully wound ready for immediate assembly. An outstanding Receiver.

Can be built for
£5 . 19 . 6
Post 4/6.

REALISTIC SEVEN De Luxe By popular request a De Luxe version of the well-known Realistic Seven now available. With the same electrical specification as standard model—PLUS A SUPERIOR WOOD CABINET IN CONTEMPORARY STYLING covered in attractive washable material, with super-chrome trim and carrying handle. Also a full vision circular dial, externally mounted to further enhance the pleasant styling. **ONLY £1 EXTRA.**
Both models: Battery 3/9 extra. (All components available separately). Data and instruction separately 2/6, refunded if you purchase parcel.

SINCLAIR SUPER MINIATURES

THE MICRO-6 Self-contained pocket radio, size only 1⅝in. × 1⅛in. × ¼in. Truly amazing performance. All parts complete with earphone and detailed construction data. Mercury cell 1/11 extra (2 required). CAN BE BUILT FOR **59/6**

THE SLIMLINE The new 2-transistor pocket radio size only 2¼in. × 1⅜in. × 1⅛in. Micro alloy transistorised and printed circuit. All components available separately. Easy to assemble. CAN BE BUILT FOR **49/6**

THE NEW X10 10 watt power amplifier fitted with integrated pre-amplifier. Requires only 1 mV. for an output of 10 watts undistorted. Size only 6 × 3 × ¼in. Weight 5 oz. Circuit uses 7 M.A.T.s and 4 RF power transistors. KIT PRICE **£5.19.6**

AVAILABLE READY BUILT, TESTED AND GUARANTEED, **£6/19/6** POST FREE.
3 pots. for vol., Bass and Treble. 7/6 the 3 extra. Mains power pack, if required, 54/-.

MINIATURE EARPIECES for Transistor Radios. Transparent ear inserts with 3ft. cord, sub-min. jack and socket. Fully guaranteed. Post free.

CR.5.	Crystal high imp.	5 0
MR.4.	Magnetic low imp.	6 6

CONSTRUCTORS BARGAINS

THE NEW "KUBA" IMPORTED AM/FM STEREO RADIOGRAM CHASSIS

Long, medium and short waveband coverage, plus V.H.F./F.M. Piano key wavechange. Separate flywheel tuning on A.M. and F.M. Bass, treble and balance controls. Magic-eye tuning indicator. Ferrite rod aerial. The very latest printed circuitry. Provision for multiflex. 5 valves: line-up: ECC85, ECH801, ECC83, ELL80, EAF801. Full vision tuning scale size 21 × 6in. Overall dimensions 21 × 6¼ × 8in. Made to the very highest standards. 3Ω output. 5 watts per channel.

LASKY'S PRICE **29½ GNS.** Carriage Free.

BUILD A HIGH QUALITY TAPE RECORDER

Using the famous Collaro "STUDIO" deck and MARTIN pre-assembled amplifiers, 2- or 4-track models.

COLLARO STUDIO TAPE DECK.
Latest model 3 speed, 3 motors. Takes 7in. reels. Fitted with half-track heads. New and Unused. LASKY'S PRICE £10/10/-. Carr. & Pack. 7/6.

COLLARO STUDIO TAPE DECK. As above but fitted with the latest quarter-track heads. LASKY'S PRICE £13/19/6. Carr. & Pack. 7/6.

MARTIN TAPE RECORDER AMPS. Designed for use with Collaro Studio Tape Deck. In sub-assemblies for immediate installation. 6-valve circuit. Comprehensive instructions make final assembly as simple as possible. Everything supplied including valves, etc. Monitoring facilities. 3 ohm output, speed equalising, etc. For 200-250 v. A.C. mains.
PRICES: ¼ track Model £11/11/-. ¼-track Model £12/12/-. Post 2/6.
Portable carrying case designed to take the Collaro Studio Tape Deck and the Martin Tape Amplifier. Fitted with 9 × 5in. speaker. Price complete with speaker £5/5/-. Post 5/-.

HI-FI TAPE RECORDER HEADS High Imp. Record/Play. Low imp. erase.

Upper or lower track. State track required	LASKY'S PRICE	29/6.
MARRIOTT "X" Type ¼-track heads	LASKY'S PRICE	4 GNS. pair.
¼-track heads Record/Play and Erase	LASKY'S PRICE	59/6 pair.
MICHIGAN ¼-track heads	LASKY'S PRICE	5 GNS. pair.
BOGEN ¼-track heads	LASKY'S PRICE	7 GNS. pair.

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High quality home construction units for the discerning Hi-Fi enthusiast. We stock the complete range of component parts.

FROM PRE-AMP TO 20 WATT HI-FI STEREO ASSEMBLY BY BUILDING WITH MARTIN AUDIOKITS—AVAILABLE FROM STOCK.

Using specially developed circuits, the very latest transistors and printed circuits—these kits are all fully checked and tested before leaving the factory.

KIT 1.	5-stage Matching Input Selector Unit	LASKY'S PRICE £2/7/6
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KIT 6.	Power supply Converter Unit	LASKY'S PRICE £2/12/6
KIT 7.	15 ohm version of Kit 5	LASKY'S PRICE £6/12/6
KIT 8.	Power supply for Kit 7	LASKY'S PRICE £2/15/-

TAPE DECK MOTORS Motors for the Collaro Studio Deck—new and unused. 200-250 v. A.C. Take-up and rewind. Listed at £2/5/- each.
LASKY'S PRICE **14/11 each** Post 2/6.
State motor required when ordering.

High quality tape deck capstan motor made by E.M.I. Holland. Bi-directional. Size 4in. dia. × 2¼in. high, 1in. × ¼in. spindle. LASKY'S PRICE **19/11** Post 3/6

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THE "TRANSISTOGRAM"

A portable battery operated fully transistorised Record Player—Made by famous British manufacturer, fully guaranteed. Size 6½ × 12 × 10½in. Weight 10 lb. Operates on 6 U2 batts. 4 speeds—16⅔, 33⅓, 45 and 78 r.p.m. Goldring Cygnet player unit with lightweight pick-up fitted with CM-60 turn over ceramic cartridge. Output 500 mW into 5in. ceramic magnet speaker fitted into lid for maximum sound distribution. Cabinet constructed of wood, covered in two tone (pale blue/grey) leather cloth. High quality amplifier with tone and vol. controls gives excellent reproduction. Plays 7in., 10in. and 12in. records. Today's value 12 gns.

LASKY'S PRICE **£6.19.6** New and guaranteed. 6 U2 batts. 4/- extra. Carr. & Ins. 7/6. (Leakproof 5/-)

TRANSISTOR POCKET RADIOS

Ideal Gifts—all supplied complete with personal earpiece, battery and carrying case. Fully guaranteed—ready to use. POST FREE.

BOY'S 2 TRANSISTOR In attractive plastic case. Size only 4in. × 2½in. × 1in. Fitted 2½in. speaker. Socket for personal earpiece. Uses PP3 battery. Tunabel over full medium waveband. LASKY'S PRICE **39/6**

BOY'S 4 TRANSISTOR MODEL LASKY'S PRICE **49/6**

6 TRANSISTOR MODEL

Fully built in plastic case, 4in. × 2½in. × 1in. with 2½in. speaker. Uses single PP3 type battery Tunable over full medium waveband. LASKY'S PRICE **59/6**

2 Waveband (Long and Medium) Model Size 5 × 3½ × 1½in. Cream/black plastic case. Real leather carrying case. LASKY'S PRICE **£5.9.6**

STAAR KINDER RECORD PLAYER

45 r.p.m. 6 v. Batt. operated. Complete with pick-up fitted crystal cartridge. Size only 7½ × 6in. Fitted auto. stop and start. As New and perfect. LASKY'S PRICE **49/6** Post 2/6.

NOW IN STOCK—2 speed model for 33⅓ and 45 r.p.m. (*As illustrated*) **59/6** Post 2/6.

THE HARROW POWER PACK

Battery eliminator for portable radios, etc. Converts your battery radio to A.C. mains. Replaces 4½ v., 6 v. and 9 v. batts. Size only 3in. × 2in. × 2½in. State Voltage required when ordering. LASKY'S PRICE **29/6** Post 2/-

GUITAR PICK-UPS

CGM3 Crystal—high imp. Size only 1½in. × ¾in. × ½in. Clips to finger board—no screws. Complete with cable. LASKY'S PRICE **15/11.** Post 1/-.

CGM35. Magnetic—high imp. Fully adjustable pick-up position carrier. Simply fixed. Separate tone and volume control. Heavy chrome finish. Pick-up size 3½in. × 1¼in., control size 2½in. × 1½in., complete with long lead and screened jack plug. LASKY'S PRICE **59/6.** Post 1/6.

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Famous American Brand—Fully Guaranteed at record low prices. In sealed cartons.

3in.	Message tape, 150ft.	3/6
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3½in.	Triple play, 600ft. Mylar base	15/-
4in.	Triple play, 900ft. Mylar base	17/6
5in.	Double play, 1,200ft. Mylar base	15/-
5in.	Long play, 900ft. Acetate base	10/-
5in.	Standard play, 600ft. P.V.C. base	8/6
5in.	Triple play, 1,800ft. Mylar base	35/-
5½in.	Double play, 1,800ft. Mylar base	22/6
5½in.	Long play, 1,200ft. Acetate base	12/6
5½in.	Standard play, 850ft. P.V.C. base	11/6
5½in.	Triple play, 2,400ft. Mylar base	45/-
7in.	Standard play, 1,200ft. Mylar base	12/6
7in.	Long play, 1,800ft. Mylar base	19/6
7in.	Double play, 2,400ft. Mylar base	25/-
7in.	Long play, 1,800ft. Acetate base	15/-
7in.	Triple play, 3,600ft. Mylar base	58/6

Post 1/- extra per reel; 4 reels and over Post Free.

TELEPHONE AMPLIFIER

Powerfully amplifies the incoming call. Fully transistorised. Pick-up suction fixed to phone. Battery-operated. Fitted with on/off switch and vol. control. Size 4½ × 3 × 1½in. Complete with PP3 battery. LASKY'S PRICE **69/6** Post 2/6.

BABY ALARM/INTERCOM

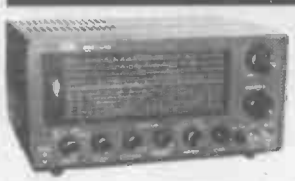
Fully transistorised miniature intercom that has all the features of sets many times its size. Battery consumption is exceptionally low and makes this system particularly suitable for use as a Baby Alarm. Specification: 2 transistor; Sensitivity; more than 55 dB. Power: one 9 v. batt. or equiv. (approx. life 50 hours). Size of units 4 × 2½ × 1½in. The sturdy plastic cabinets are finished in ivory and silver with chrome stands. Post 2/6. LASKY'S PRICE **59/6**

EXPORT MODEL—TV OFFER

625 line T.V. chassis (Export Model). For 200-250 v. A.C./D.C. mains. Fitted with Band I-III-turret tuner. Fully loaded with 12 sets of coils for all CCIR channels in these band F/M sound. Made by famous British manufacturer. 15 Mullard valves. Electrostatic focus and deflection. Will take 17in., 19in. 21in. or 23in. CRT. All controls fitted. Supplied new and unused with all valves. 7in. × 4in. speaker and 17in. CRT (less cabinet).

LASKY'S PRICE **£25** Carr. & packing FREE to any part of the World. (Tube sent at buyer's risk.) An allowance of £3 will be made if the CRT is not required. Circuit data included FREE.

COMMUNICATION RECEIVERS



MODEL HE30

Covers 540 Kc/s. to 30 Mc/s. Facilities: A.N.L., A.V.C. and M.V.C. Q Multiplier also serves as B.F.O. H.F. stage and two I.F. stages ensure high sensitivity and selectivity. 9 valves. Stand-by position for use with a transmitter, S meter fitted. 200-250 v. A.C. mains. Brand new with full instruction manual, steel cabinet, size 15 × 8 × 10in.

LASKY'S PRICE **33 GNS.** | KIT PRICE **25 GNS.** | POST FREE

H.P. Terms (Ready Built): £6/13/- dep. and 11 months at £2/16/-. Total H.P.P. £37/9/-

MODEL HE40

Covers medium wave band and 1.6-4.4 Mc/s., 4.5-11.0 Mc/s. 11.0-30.0 Mc/s. in separate switched band spread ranges. Controls B.F.O. Sensitivity, A.N.L. Receiver—Stand-by Switch, Tone Switch, S-Meter. For 200/250 v. A.C. Internal loop and telescopic antennae fitted. 4 valves and metal rectifier. Size 13½ × 8½ × 5½in. Full instruction manual. No Kits available.

LASKY'S PRICE **19 GNS.** H.P. Terms £4 dep. and 11 months at £1/12/-. Total H.P.P. £21/12/-. Carr. & Pack. 10/-

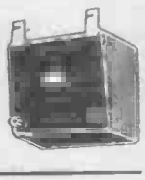
MODEL HE80

14-valves. Freq. range 540 Kc/s.—30 Mc/s. and 144-146 Mc/s. Dual conversion on 2 metres, with extra R.F. stage. Single R.F. stage, two I.F. stages on all other bands. B.F.O. and Q-multiplier circuits. Improved A.N.L. and voltage regulated powerpack. "S" meter, band spread on amateur bands. Outputs for speaker and phones. Steel case 17 × 7½ × 10in. For 200/250 v. A.C. mains. Brand new with full instruction manual. No kits available.

LASKY'S PRICE **59 GNS.** H.P. Terms £12 19/- dep. and 11 mths. at £4 18/- Total H.P.P. £66/17/-. Carr. & Pack. FREE

TEST EQUIPMENT

TEST METER ADAPTOR



Type PE 220—this is a fully transistorised device which enables any 50 microamp D.C. Multimeter to be used in place of a valve volt meter. On the 1 v. range an impedance of 1 megohm is offered which increases on the 1,000 v. range to 100 megohms. 7 ranges: 1 to 1,000 v. Designed for immediate connection to Avo 7, 8 and similar size meters but quite suitable for use with any other 50 microamp meter. Size 6 × 6 × 5in. New and boxed. List Price 7 Gns.

LASKY'S PRICE **39/6.** Post 2/6. Set of batteries 7/5 extra.

TEST METERS

brand new—complete with test leads and batts.

HAIKI 20,000 O.P.V.	£5	19	6	P-1 2,000 O.P.V.	£2	12	6
TE-13 1,000 O.P.V.	£1	19	6				
TMK-500 30,000 O.P.V.	£8	17	6	P-3 4,000 O.P.V.	£4	2	6
200-E 20,000 O.P.V.	£5	5	0	MT-559 50,000 O.P.V.	£10	19	6

Complete range of Avo and Taylor Meters and Test Equipment in Stock, also complete range of all Nombrex and Jason Test Equipment.

CRYSTAL PICK-UP CARTRIDGES

LOWEST PRICES EVER!

All Complete with Styli L.P. and Standard, fully guaranteed. Standard Fitting will fit most P.U. Arms and Heads. Postage 1/- extra each.

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Acos G.P.65/3	15/-
Acos G.P.65/1	17/-
Acos G.P.67/1	14/-
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Ronette Stereo G.V. Turnover with 2 sapphires	25/-
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Ronette Stereo type 105 and 106 with diamond LP/Stereo and sapphire Std.	35/-

AND EVEN LOWER PRICES

Save money! Some of these cartridges are cheaper than styli

C.T.1 Mono, 2 sapphires	4/11
Collaro Type C, 2 sapphires, stereo	15/-
Collel SC1 Diamond LP, stereo	17/6
Sonotone 8T, stereo	19/10
Sonotone 2TA, mono	15/-

Postage 1/- extra each.

TAPE POSITION INDICATOR

Open type—as used by most makers. With re-set knob. 3 DIGIT 7/6. 4 DIGIT 10/6. Post 9d. on each.

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Super Spring Bargain for Motorists

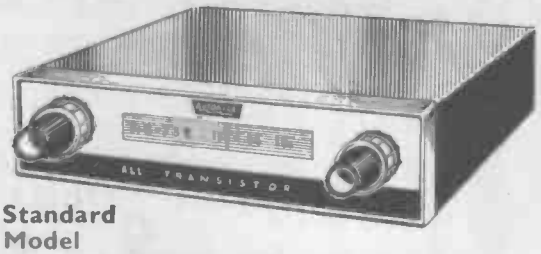
CAR RADIO SCOOP!

VERY LIMITED STOCK—DON'T DELAY

BY FAMOUS BRITISH MANUFACTURER—READY TO FIT

Standard Model

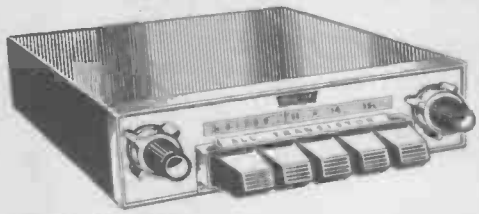
A high quality all transistor car radio covering the full Medium waveband. For use on all 12 v. D.C. systems—positive or negative earth. Very attractively styled in silver and black to harmonise with all interior styles. Standard dimension steel case 7 x 7 x 2in. complete with metal fixing brackets. Illuminated dial, "easy hold" control knobs. Tunable over full medium waveband—200/550 metres. Leads are fitted for battery, aerial and loudspeaker connections, a fuse is incorporated in the battery lead. Technical details: 12 v. D.C., positive or negative earth; tuned R.F. stage superhet; fully transistorised using 7 semi conductors; power transistor with 3 ohm output sufficient for the largest car; permeability tuning for positive selection and stability. Instruction book and service manual including circuit diagram supplied. New and unused in makers original cartons. **Fully guaranteed. Today's value almost double.**



Standard Model

LASKY'S PRICE £6.19.6 Post 5/6

Excluding speaker and aerial — see list below.



De Luxe Model

Incorporating push-pull output providing 6 watts output together with fully variable tone control and five push button station preselectors. Ready to fit. Size—finish, etc., as standard model. Brand new and unused in makers original cartons. Fully guaranteed.

De Luxe Model

LASKY'S PRICE £8.19.6 Post 5/6

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A SELECTION OF SUITABLE AERIALS & SPEAKERS

LOUDSPEAKERS.
5in. round 10/6. 7 x 4in. elliptical 11/6. 8 x 5in. elliptical 12/6. Post 1/6.

SPEAKER ESCUTCHEONS.
Chrome plated with matching grille, complete with fixing bolts. New and boxed. 5" round 12/6. 7" × 4" elliptical 15/6.

AERIALS. All heavily chrome plated, complete with connecting lead and plug. **Fully retractable.** Type A28 open 41in., closed 9in. 50/-. Type A24 open 61in., closed 16in. 55/-. Type A20 open 41in., closed 9in. (with locking device) 52/6. **Wing Mounting.** Type A13 opens to 48in. 25/-. Type A40 opens to 62in. 46/-. Post 2/-.

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Carriage and Insurance extra.

THE "TRAVLER" Mk. II CAR RADIO

★ MEDIUM AND LONG WAVES
★ 12 VOLT POSITIVE EARTH
★ PUSH BUTTON WAVE CHANGE
★ SIZE 7in. x 2in. x 7in.
★ TRANSISTORISED

ONLY **9½ GNS.** P. & P. 5/-.

Ready built complete with 7 × 4in. speaker fitted to baffle, fixing brackets, filter unit, all nuts and bolts and fitting instructions.

Optional extras: 3-section chromium plated weatherproof telescopic aerials. Type 1, 17in./44in. 19/6. Type 2, 2in./43in. 29/6, both plus p. and p. 2/6 if purchased separately.

THE "HIGHWAYMAN" CAR RADIO
TO BUILD YOURSELF

Similar in appearance to above but with on/off push button switch. Complete set of parts only **£7.19.6** P. & P. 5/-.

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Carriage and Insurance 5/- each.
Descriptive Leaflets free on request.
Please state model required.

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GREAT BRITAIN'S GREATEST

STERN-CLYNE HI-FI EQUIPMENT
Ready built or Kits of Parts

	Complete Kit of parts	Ready built and tested	Carr. and Ins.	Instruction book available separately
Stern Mono-Gram Amplifier, 3 watts	£4 10 0	£6 0 0	3/6	2/6
Mullard 2-valve Audio Pre-amplifier	£6 6 0	£9 10 0	5/-	2/-
Mullard 3-valve Audio Pre-amplifier	£10 0 0	£13 13 0	5/-	3/6
Mullard "3-3" Amplifier with Passive Control Unit Model 33/RC, 3 watts	£8 8 0	£11 10 0	6/6	2/-
Mullard "5-10" Main Amplifier, Model 510/M, 10 watts	£10 0 0	£13 10 0	6/6	2/-
Mullard "5-10" Amplifier with Passive Control Unit, 10 watts	£12 0 0	£16 0 0	7/6	2/-
Stern Twin Three Stereo Amplifier, 3 watts per channel	—	£9 0 0	5/-	—
Stern Twin Three Stereo Amplifier in Portable Case with Two Speakers and Leads	—	£16 10 0	10/-	—
Mullard "10+10" Stereo Amplifier, 10 watts per channel	£16 0 0	£20 0 0	8/6	3/-
Mullard "10+10" Stereo Amplifier with Passive Control Unit, 10 watts per channel	£20 0 0	£24 0 0	10/-	3/-
Mullard Dual Channel Pre-amplifier	£12 0 0	£15 0 0	7/6	3/-
The above two items purchased together	£27 0 0	£34 0 0	15/-	—
HF/TR3 Tape amplifier with Power Unit	£13 13 0	£19 0 0	7/6	3/-
Type 'C' Tape Pre-amplifier with Power Unit	£14 0 0	£19 10 0	7/6	3/6
STP-1 Tape Pre-amplifier with Power Unit Mono and Stereo	£22 0 0	£28 0 0	8/6	5/-
CR3/S Tape Recorder with Studio Deck	£33 8 0	—	15/-	3/-

INDIVIDUAL DESCRIPTIVE LEAFLETS GIVING TECHNICAL SPECIFICATIONS, DIMENSIONS, PRICES. TERMS, ETC., FREE ON REQUEST.

RECORD PLAYERS

Garrard SRP10 Single Player £5 9 1
LATEST B.S.R. UA25 4 speed changer £5 19 6
Garrard Autoslim Autochanger £6 10 0
B.S.R. Super Slim Changer £9 19 6
Garrard AT6 Changer £10 19 6
Garrard AT5 LM Autochanger (3000LM) £11 11 11
Philips AG1016 Stereo/Mono Record Player..... £13 13 0
Garrard 4HF Single Player £16 17 6
Goldring Lenco Model 88 Transcription Turntable £18 18 5
Garrard Laboratory Type "A" Autochanger £19 15 0
Garrard 301 Transcription Turntable (Strobe).. £22 0 5
Carr. and Ins. 5/- on above.
Descriptive Leaflet including prices with alternative cartridges, dimensions, terms, etc., free on request.

MICROPHONES
Extensive range available, send S.A.E. for illus. brochure.

ANOTHER STERN-CLYNE BARGAIN OFFER!!

SAVE £10!

STEREO AM/FM
RADIOGRAM CHASSIS
BY FAMOUS MAKER
LIST PRICE £30.17.11

OUR PRICE **19 GNS.** Carr. 7/6

BRAND NEW WITH FULL GUARANTEE

Full Medium, Long and V.H.F. Coverage.
3 watts per channel output. 3 ohm output impedance. Internal aerial for A.M. Provision for Multiplex adaptor. Pick up and Tape input sockets. A.C. mains 200/250 volts.

FREE OFFER!!

Two 10in. x 6in. matching speakers supplied free if the following items are purchased together. CHASSIS 19 GNS. and GARRARD Autoslim with stereo plug in head £8/7/- (or any unit above £8/7/0). Carr. 15/- extra.

NEW LOW PRICE COMMUNICATION RECEIVERS

HE-40. 550 Kc/s.-30 Mc/s. in 4 bands. £19/19/-. Carr. 10/-.

HE-30. 550 Kc/s.-30 Mc/s. in 4 bands. £34/13/-. Carr. Paid.

KT-320. As HE-30 but offered as complete kit of parts. £26/5/-. Carr. Paid.

HA-63. 550 Kc/s.-31 Mc/s. in 4 bands. £25/4/-. Carr. Paid.

STARFLITE 90 WATT TRANSMITTER
Band coverage 80-40-20-15 and 10 Metres. £30/9/-. Carr. 15/-.
H.P. Terms available.

Send S.A.E. for fully descriptive brochure.

-CLYNE

ELECTRONIC HOBBIES ORGANISATION

DOUBLE FEATURE PRE-AMPLIFIER AND JL10 POWER AMPLIFIER

DOUBLE FEATURE PRE-AMPLIFIER. Inputs for microphone, crystal or magnetic pick-ups, tuner unit and in addition offers full facilities for tape recording and high fidelity replay. This unique feature means that should you wish to include tape in your hi-fi system at a later date all that is required is a suitable tape deck. Push-button switching for 3 tape speeds equalised.
BUILT AND TESTED 18 GNS. (C. & I. 5/-)

JL10 POWER AMPLIFIER. Incorporates the latest diode/pentode ECL86 valves in push-pull. PARTRIDGE ultra linear output transformer. PARTRIDGE mains transformer and smoothing choke. 10 watts power output, surplus power available for tuner.
BUILT AND TESTED 12 GNS. (C. & I. 7/6)

Prices if both units purchased together:
BUILT AND TESTED 29 GNS. (C. & I. 10/-)

NEWS FOR THE SHEFFIELD CUSTOMERS
Visit us on **STAND 48** *at the*
Sheffield Ideal Home Exhibition—May 19th - 29th

TAPE EQUIPMENT AND ACCESSORIES

AMERICAN RECORDING TAPE

5in.	600ft. Standard Acetate	8/6
5in.	900ft. Long Play Acetate	10/-
5½in.	1,200ft. Long Play Acetate	12/6
3½in.	600ft. Double Play Polyester	11/6
7in.	1,200ft. Standard Play Polyester	12/6
5in.	1,200ft. Double Play Polyester	15/-
7in.	1,800ft. Long Play Polyester	20/-
5½in.	1,800ft. Double Play Polyester	22/6
7in.	2,400ft. Double Play Polyester	25/-

P. & P. 1/- per Reel extra, 4 or more Reels POST FREE.

Fully Automatic Tape Splicer 14/6. P. & P. 1/6.
Plastic Tape Spools 2½in. 1/-; 3in. 1/3; 4in. 2/-; 5in. 2/-; 5½in. 2/3; 7in. 2/6.
Plastic Spool Containers, for spool sizes 5in. 1/6; 5½in. 2/-; 7in. 2/3.

Any single item plus 6d. P. & P. Orders over £1 POST FREE.

VISIT YOUR NEAREST STERN-CLYNE ELECTRONICS CENTRE

LONDON
.o, Tottenham Ct. Rd., W.1. MUSeum 5929/0095. *Half day Sat.*
23, Tottenham Ct. Rd., W.1. MUSeum 3451/2. *Half Day Thurs.*
309, Edgware Rd., W.2. PADdington 6963. *Half Day Thurs.*
109, Fleet St., E.C.4. FLEet St. 5812/3. *Half Day Sat.*
162, Holloway Rd., N.7. NORth 7941. *Half Day Thurs.*
9, Camberwell Church Ct., S.E.5. RODney 2875. *Half Day Thurs.*

CROYDON
12, Suffolk House, George St. MUNicipal 3250. *Half Day Wed.*

BRISTOL
26, Merchant Street, Bristol, 1. Bristol 20261. *Open 6 Days a week.*

LIVERPOOL
52, Lord Street. Royal 7450. *Open 6 Days a week.*

MANCHESTER
20/22 Withy Grove, Manchester 4. BLAckfriars 5379/5246. *Open 6 Days a week.*

SHEFFIELD
125, The Moor, Sheffield. Sheffield 29993. *Half Day Thurs.*

MAIL ORDERS AND ENQUIRIES TO:
Dept.W.W. 3-5, Eden Grove, Holloway, London, N.7. NORth 8161/5

FLOODLAMP CONTROL

Dim and full switch for controlling photo floodlamps. Gives two lamps in series, two lamps full brilliance and lamps off. Similar control of other appliances. With circuit 3/6, plus 9d. postage.

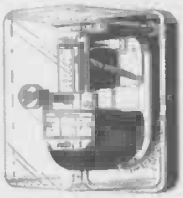
Suppressor Condensor

Stop your drill or other appliances interfering with your or your neighbours' radio or television. Simple instructions given. 1/6 each. 12/- dozen.

FINE TUNERS

50 pf. with long spindle as illustrated. 1/6 or 12/- dozen.

OVERCURRENT RELAY



Beautifully made by the famous American Westinghouse Company. These are the surface mounting through panel type with clear Pyrex glass covers. They have coils for remote push button resetting. Type "A"—Calibrated for currents between .1 and .4 amps. Type "B"—Calibrated for currents between .5 and 2 amps. Price, unused and perfect, 29/6 plus 3/6 post.

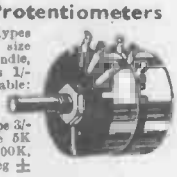
Microphone Inserts

American made. Dynamic type. Real bargain at 2/6, plus 6d. postage.

Fishing Rod from Dinghy Mast

Tubular aluminium mast in separate sections, extends like telescope from 15in. to 9ft. 6/6 each.

Morganite Protentiometers



Single and 2-gang types available, standard size with good length spindle, all new. Single types 1/- each, values available: 5K, 10K, 25K, 50K, 100K, 250K, 1 meg, 2 meg. Gang type 3/- each, values available 5K ± 5K, 100K ± 100K, ½ meg ± ½ meg., 1 meg ± 1 meg.

Building a 'Scope

3in. oscilloscope tube. American made type No. 3FP7, 6.3 v. 0.6 amp. heater electrostatic deflection, brand new and guaranteed with circuit diagram of 'scope 1/- each, plus 2/6 post and insurance.

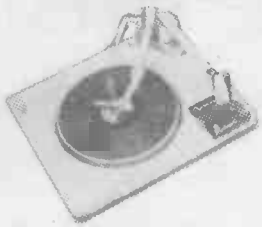
Timer Kit

Special offer of all components except metal box to make mains operated interval timer for photography, etc. 12/6, plus 2/6 post.

Where postage is not definitely stated add 2/- to all orders under £3.

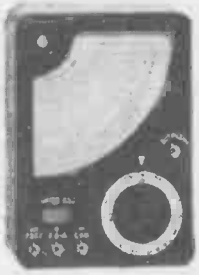
AUTO CHANGER BARGAIN

GARRARD AUTO-SLIM RECORD CHANGER



One of the nicest record changers that this famous company make—Automatic selection of records which may be mixed —may also be played manually. Finger tip adjustment of Stylus pressure. Fitted' with mono head—but pickup wired for stereo—suitable 200/250 A.C. mains—cabinet space required 14½ × 12½ with 4½in. above and 2½in. below. DON'T MISS THIS SPECIAL SNIP, ONLY £5 15/-. (Post and ins. 6/6.)

MULTI-METER BARGAIN



Model number EP10K. Extra wide scale fitted corner-wise for compactness, extra accurate as it uses 1% components. Sensitivity 10,000 ohms per volt. A.C. and D.C. ranges. D.C. voltage up to 1.2kV in 5 ranges. A.C. voltage up to 1.2kV 5 ranges. D.C. current up to 300mA 3 ranges. Resistance up to 2 meg. Capacities 0.05 to .15 mfd. and decibels. Complete with full instructions and test prods and battery for ohms range. A real bargain not repeatable once stocks cleared. Price 69/6. Carriage and insurance 5/-.

THIS MONTH'S SNIP

CABINET & PICK-UP

Cabinet for battery record player. Size approx. 9 × 11 × 5in., allows for 7 × 4in. speaker and amplifier. Nicely covered, two tone. Must have cost at least £2 to make. New and perfect. Offered whilst stocks last.

ONLY 15/6 Plus 4/6 post and insurance.

TAPE RECORDER that will play in your pocket

Undoubtedly one of the smallest precision tape recorders made. Entirely controlled by push buttons, you can record and play back with the instrument in your pocket. It is a full function machine using standard ¼in. tape and easy to replace batteries. Speaking and playing back is from the same (crystal) microphone.
Specification: Dimensions 6½ × 2½ × 1¼in., weight 14 oz.; recording time: 12 mins. rewinding time, 4 mins.; recording system: D.C. Bias; erasing system: Magnetic erasing; wow and flutter within 2% and frequency response; 500-1,200 c/s (within—6dB).
Complete ready to work. PRICE **£9 19s. 6d.** plus 3/6 post and ins.

750 mW TRANSISTOR AMPLIFIER

4 transistors including two in push-pull input for crystal or magnetic microphone or pick-up—feed back loops—sensitivity 5 m/v. Price 19/6.
Post and ins. 2/6. 35 ohm speaker 12/6 extra.

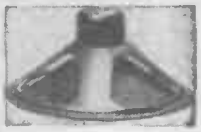
OSCILLATING UNIT 12A

This is a precision instrument covering the range 30 to 41 MC/SEC with tone switching for 700, 1,150 and 1,700 cycles per sec and magic eye tuning indicator. Unused in original transit cases with attenuator box. Limited quantity. Only £5 each, carriage paid.

MAINS POWER PACK

MAINS POWER PACK designed to operate transistor sets and amplifiers. Adjustable output 6 v.—9 to 12 volts for up to 500 mA. (class B working). Takes the place of any of the following batteries. PR1, PP3, PP4, PP6, PP7, PP9, and others. Kit comprises: mains transformer-rectifier, smoothing and load resistor, 5,000 and 500 mfd. condensers, zener diode and instructions. Real snip at only 14/6, plus 2/6 post.

SPEAKER BARGAIN

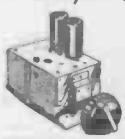


12in. High fidelity loudspeaker. High flux permanent magnet type with either 3 or 15 ohm speech coil. Will handle up to 10 watts. Brand new, by famous maker. Price 27/6, plus 3/6 post and insurance.

Hi-Fi Speakers

E.M.I. Ceramic magnet 12,000 lines, size 13in. × 8in. (roughly equivalent to 12in. round speaker). Base frequency 40-50 c/s. Handles up to 10 watts. Price 33/6 plus 5/- carriage and ins. State whether 15 ohm or 3 ohm.

Brayhead Turret Tuner



Complete with Band 1 and Band 3 coils. Less valves, 10/- each, or with valves 17/6 each. Post 2/6. Knobs 3/6 extra.

Waterproof Heater Wire

16 yd. length. 70 watts. Self regulating temperature control. 10/- post free.

Cabinet snip

This fine cabinet as illustrated but less control knobs is available this month at a special snip price of 12/6, plus 3/6 post and insurance. Size is 3¼in. × 9in. × 4in. and it is nicely covered in two-tone I.C.I. fabric.

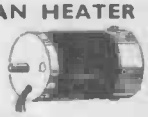
SIEMENS HIGH SPEED RELAY

Twin 250 ohm coils adjustable tension change over contacts—plat. points. 7/6, post 1/-.

FIVE CORE CABLE

Ideal for switching circuits, intercoms., P.A. runs, etc., each core flex copper with rubber insulation cores covered overall in tough rubber or P.V.C. 9d. per yd. or 30 yds. length 15/- plus 5/- post.

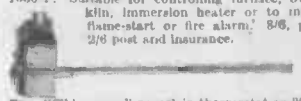
MAKING A FAN HEATER



Miniature motor, laminated poles. Operates off 20-30 v. D.C. Original cost at least £3 each. 8/6 plus 1/6 postage and insurance. Mains model 9/6, plus 2/6 postage and insurance.

THERMOSTATS

Type 'A" 15 amp. for controlling room heaters, greenhouse, airing cupboard. Has spindle for pointer knob, quickly adjustable from 30-80°F., 9/6 plus 1/- post. Suitable box for wall mounting, 5/-. P. & P. 1/-.
Type "B" 15 amp. This is a 17in. long rod type made by the famous Sunvic Co. Spindle adjusts this from 50-550°F. Internal Screw alters the setting so this could be adjustable over 30° to 1000°F. Suitable for controlling furnace, oven, kiln, immersion heater or to make flame-start or fire alarm. 8/6, plus 2/6 post and insurance.



Type "C" is a small porcelain thermostat as fitted to electric blankets, etc. 1½ amp. setting adjustable by screw through side. 3/6, P. & P. 6d.
Type "D" We call this the Ice-stat as it cuts in and out at around freezing point 2/3 amps. Has many uses, one of which would be to keep the loft pipes from freezing. If a length of our blanket wire (16 yds. 10/-) is wound around the pipes, 7/6. P. & P. 1/-.
Type "E" This is a standard refrigerator thermostat. Spindle adjustments over normal refrigerator temperature, 7/6, plus 1/- post.

ELECTRONICS (CROYDON) LTD

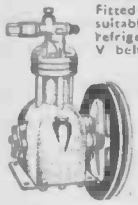
266 LONDON ROAD · WEST CROYDON · SURREY

Post orders to: Dept. W.W. 43 Silverdale Road, Eastbourne, Sussex

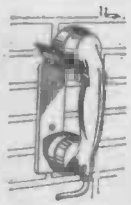
BARGAINS GALORE—WAREHOUSE BEING CLEARED

FLEXIBLE COUPLINGS
These couplings extend as well as bend for joining shafts out of alignment and for slug tuning controls where the core has to come in and out. Price 10/- doz.

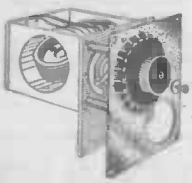
COMPRESSOR/VAC PUMP
Fitted with outlet and inlet valve, suitable for paint spraying, refrigerator etc., complete with V belt drive wheel. Price 27/6. P/P 2/6.



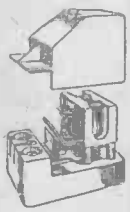
SHEET PAXOLIN
Ideal for transistor projects. Size 6 x 6in. 1/-, 12 x 8in. 2/-, 12 x 12in. 3/6, 24 x 12in. 6/-, 25% discount in doz. lots, special offer 12 panels 5 x 8in. 5/-.



SELF ENERGISED TELEPHONES
These require no batteries in fact they have only to be connected by a pair of wires. They can thus be fitted into existing bell circuits. Results are extremely good and maintenance costs are nothing. Handsets only complete as illustrated. 15/- each, 2/6 post. Two post free.

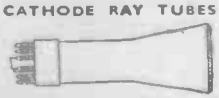


VARIOMETER ASSEMBLY
As illustrated this is useful for experimental circuits, crystal sets, etc. Price 3/9 each.



RELAYS
Totally enclosed in bakelite, this relay has a 24 volt coil but can of course be rewound for mains operation. Its contacts are suitable for breaking 20 amps. Price 2/6 each, 24/- doz.

CATHODE RAY TUBES



VCR517 6in.	9/6 carr. and ins.	8/6
(replaces VCR 97 new and unissued)		
VCR 139A 2½in.	27/6 carr. and ins.	4/6
VCR 138 3½in.	27/6 carr. and ins.	5/6
VCR 4/1 3in.	32/6 carr. and ins.	4/6
VCR 112 5in.	27/6 carr. and ins.	5/6
CV 996 6in.	22/6 carr. and ins.	5/6
VCR 97 6in.	42/6 carr. and ins.	8/6
CV 1140 12in.	27/6 carr. and ins.	12/6
CV 1590 12in.	27/6 carr. and ins.	12/6

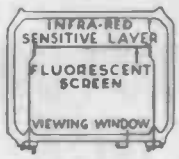
10 way Cable, ideal for interconnecting units and for remote switching circuits—each way has a flex copper core capable of carrying 5 amps and insulated to 500 v. The cable is P.V.C. covered overall. Price 1/6 per yard. 10 yards post free, otherwise add 3/6 post.

Twin Rubber High Current Flex. 110 strand in each core, 250 volt grade; carry a length of this in your car—if you are ever stuck with a flat battery you can join up to another car; regular price of this cable is 3/- per yd. Our price 17/6 for 10 yds. post paid.

Bakelite Wall Switches. Normal household type for lighting, etc., 9/- doz. one way or 10/- 2 way—36 or over post free, otherwise add 2/6.

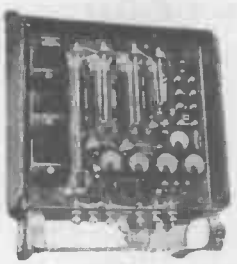
A.C. Mater, Wall or Panel Mounting. Voltmeter 6in. dia. in metal box for flush mounting—install one in your workshop and you will always know how the mains are. 35/- each, 3/6 post and ins.

SNIPERSCOPE
Famous war-time "cats eye" used for seeing in the dark. This is an infra-red image converter cell with a silver caesium screen which lights up (like a cathode ray tube) when the electrons released by the infra-red strike it. It follows that as light from an ordinary lamp is rich in infra-red these cells will work: burglas alarms, counting circuits, smoke detectors and the hundred and one other devices as will the simpler type of photo cell. Here then is a golden opportunity for some interesting experiments, price 5/- each, post 2/-. Data will be supplied with cells if requested.



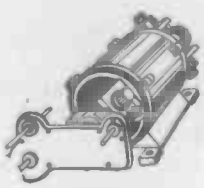
TELEPHONE REPEATER No. 1 MARK 1. This equipment is for amplifying telephone signals in both directions of traffic and also to remedy line distortion of speech. It is intended for use with two wire or four wire circuits, has four amplifiers and is in fact two quite independent repeaters mounted on the same panel and having a common power supply. The power supply may be operated from a 12-volt car battery or from standard A.C. Mains. The units are absolutely new in original packing complete with spares and instructional manual. £7/10- each and 20/- carr. and ins.

CHARGING SWITCHBOARDS
Type A, 550 w. 18 v.—contains three reverse current relays, one voltmeter rated 25 v. f.s.d., one main ammeter rate 40 amps f.s.d., one secondary ammeter rated 15 amps f.s.d., and two secondary meters rated 20 amps f.s.d., one 2 ohm variable resistor, one 11 ohm variable resistor and two 1.2 ohm variable resistors. Complete in metal case 2ft. 6in. x 2ft. 8in. approx. Price £2/15/-, carriage and ins. 15/-. **Type B,** 1260 w. 50 v., 12 amps.—contains one 14 ohm variable resistor and four, 1 ohm variable resistors, one main ammeter rated at 40 amps f.s.d., four secondary meters rated at 20 amps f.s.d., and one voltmeter rated at 50 volts, and two reverse current relays. Complete in metal case—size approximately 2ft. 6in. x 2ft. 8in. Price £4/15/-, carriage 15/-.



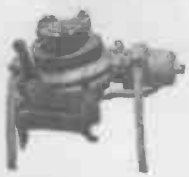
hurry or you may be too late

See last two months adverts for more bargains but please note we are sold out of the following: Ferranti Meters—Klystron Receivers—25 amp. contactors—Motorised Rotary Switches.



MULTI-SPEED MOTORS
You can adjust this motor to almost any speed you want, it will work directly off A.C. mains, or if you require greater power or greater speed, work it through a metal rectifier. This motor is fitted with a gear box enabling speeds down as low as 1 r.p.m to be obtained. Price 19/6 postage and packing 3/6 extra.

UNITS FOR CONTROLLED AUTOMATIC ROTATION



Two units work together to form a Tower rotating device, with remote control.

Item 1, known as Tower 24A, is in fact the geared driving motor which rotates the mast. This is quite a heavy construction and would rotate a heavy scanner, reflector, Beam array, etc., etc.

Item 2, known as Indicator I-221-A is the remote controller which enables the azimuth position of Tower 24A to be controlled from a remote point. Conversely, it enables the azimuth position of the tower to be known at any time. Both the Tower and the Indicator contain selsyn transmitter/receivers and it is these that provide the impulses which cause the aerial to rotate backwards or forwards. The equipment intended for 117 volt. A.C. mains but will operate from our mains if connected through step down transformer of 1 K.W. rating.

Prices I-221-A £25, TR24A £35.

Special discount of £5 for cash with order or C.O.D. if both units purchased together.

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Dept. W.W.

43 SILVERDALE ROAD, EASTBOURNE

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Toggle Panel-Switch. 25/30 amp. single pole, 2/6 24/- doz.

Toggle Switch. 10 amp. double pole, 2/-, 18/- doz.

Electric Lock. 24 v. coil but rewindable to alter voltages 4/6, 48/- doz.

Dynomotor. American make input 27 v. output 285 v. 20 watt. Totally enclosed 15/-, post etc. 2/6.

EHT Rectifier. CV 111, 15 Kv. 350 M.A. (peaks) 6/-, £3 doz.

Ceramic Holder, for CV111 rectifier 2/6, 24/- doz.

Wafer Switch. 12 assorted types all very useful 10/-, post 2/6.

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½ Meg Potent Meters. Sealed type by Morganite among the best ever made, standard ¼ spindle, 1in. long, 6/- doz.
100K ditto 5/6 doz., 50 K 5/- doz.

MU Metal Screen for American 5 CP1 etc. 6/6 pair for VCR97 and other 6in. tubes, 7/- complete.
ditto for 2"-3" tube 5/- complete.

8 Way Connectors. Male and female to permit chassis units to be plugged into one another 3/6 pair, 36/- doz.

Screened Sleeving 6 MM, 6/- doz. yards.

Reverse Current Relays. 12 to 18 v. 12/6, 6 for 70/-.

P.M. Speaker Bargains. 8in. P.M. by Rola/Celestion fitted with standard Pentode output transformer, 12/6 + 3/-. Ditto but 6½in., 11/6 + 3/-.

12 Volt Vibrator, 4 pin, standard for most car radios, 7/6, 36/- ½ doz.

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American made—matching pair comprising Transmitter and Receiver, with diagram £15 the pair.

Vibrator Invertor. American made d.c. input 24 v. Two A.C. outputs each 16 v. at 100 M.A. 60 c.p.s., 15/-.

Vibrator Unit. British made d.c. input 24 v. gives 250 v. d.c. at 80 M.A. using metal rectifier, 25/-.

Vibrator Unit. Canadian made d.c. input 2 v. gives 90-180 v. d.c. at 35 M.A. uses synchronous vibrator also gives 1.4 dc. for filaments 35/- + 2/6.

Rotary Transformer for working 200/240 d.c. or AC/DC appliances from 12 volt. Car battery, output 200 v. at 100 M.A., 35/- + 3/6.

Trimmer Bank. 5 x 50 pf compression trimmers mounted on metal strip 3½in. long, ideal if making present station receiver—ceramic/mica insulation, 2/- each, 18/- doz.

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Twin type with spindle 18/- doz.

Toughened Glass. Can be dropped, walked on, etc., unlikely to break unless struck on edge. Then it turns into unharmful crystals. 5 panels each 10½ x 9½, 5/- + 3/- post and ins.

Ignition Coil, 12 v. suits most cars—useful for E.H.T. experiments, 12/6.

E.H.T. Smoothing Condenser, .1 mfd. 10 KV. 6/-, £3 doz.

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Miniature Relay. American make—630 ohm coil 20-30 v. operation—two pole change over contacts, 2/6, 24/- doz.

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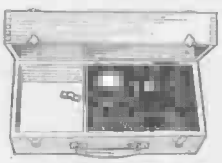

Centre Zero Galvanometer. Scaled 20—0—20 2½in. movement, 2.5 mA. full scale deflection. 3 stud switch controls 0-10, 0-100 ohms, 0-Inf. Complete in carrying case with instructions, 45/-. Post 7/6.

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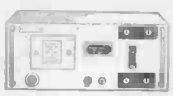

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Fully tested

Model 1052 £27/10/-. Carr. 20/-.
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BRAND NEW. Chamois padded, complete with jack plug, 15/6. Post 2/-.

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Cossor miniature, H.F. chokes..... 1/3

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TCC tubular condensers, 75 pf., 5,000 v. D.C. working 1/9
TCC base mounting condensers, .02 mfd., 11,000 v. D.C. working 25/-
TCC base mounting condensers, 2 mfd., 10,000 v. D.C. working £12
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Miniature potentiometers, 1 meg. 2/-
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Colvern wire wound potentiometers, 20,000 ohms, pre-set type 3/-

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Heavy duty unit, input 230 v. Outputs 4.5 v. C.T. at 6 amps., 4.5 v. C.T. at 6 amps., 4.5 v. at 20 amps., C.T. Price £3/10
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GCRE FSI0 AUDIO FSK TERMINAL UNITS

Completely self contained, with internal mains supply, input and output sockets, carpenter relay type 5A6, mark space meters, etc., in perfect working order, condition as new. Size 19 x 9 x 5in. Price ..... £8/10 P.P. 15/-

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Type CT-49

Range 450 c/s to 22 Kc/s in four directly calibrated ranges Power supplies 1.5 v and 22 v dry batteries, an ideal unit for teleprinter/F8K work. New boxed equipment, small size £8/10. P.P. 12/6

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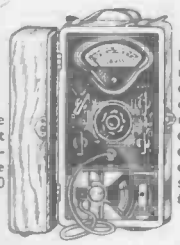

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Special quotations for quantities.

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RELAYS, MINIATURE
S.T.C. 4184GD, 24 v. 700 ohms, 2 C.O.
S.T.C. 418gb, 6 v. 45 ohms, 2 C.O.
S.T.C. 4184GE 48 v. 2,700 ohms 2 C.O.
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All above relays 8/6 each, plus P.P. on all relays 1/-

MINIATURE RELAY BANKS

Six miniature relays 9-12 v., 1 make per relay, contained in neat aluminium case 6 x 4 x 1¼in., with six half inch spaced crystal holders, designed to switch any desired crystal by remote control. Relays and crystal holders can be easily removed for other uses if required, terrific value, only 15/6. P.P. 1/6.

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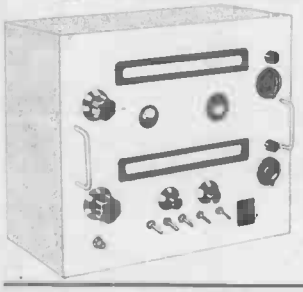

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Total Frequency Coverage 20-1,000 Mc/s.

The instrument consists of: Crystal Controlled Oscillator (Crystal 100 kc/s. ±5 c/s.) providing spot frequencies at 25, 50 and 100 kc/s. intervals; Fine (L.F.) Oscillator continuously tuned from 5.0 to 6.25 Mc/s. in 9 bands; Coarse (H.F.) Oscillator continuously tuned from 20 to 300 Mc/s.; and associated mixer and A.F. stages. By using coarse oscillator alone quick frequency identification can be made from 20 to 1,000 Mc/s. with an accuracy of 3%. By using correct measuring procedure, i.e., by calibrating fine oscillator against crystal and beating input frequency with the former an accuracy of ±.02% is easily obtained. Long scales graduated in Mc/s. provide exceptional degree of discrimination. Beat detection by Magic Eye or headphones. Dimensions: 22in. × 19½in. × 14in. Weight 71 lb. Power requirements 115/230 v. A.C.

PRICE, new and fully guaranteed £85 0 0

Packing and carriage £1/10/-.

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Input: 110/230 v. A.C.
Output: 240 v. ±1.5%.
Max. Current 1 A.

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The Echo Box (Resonator) consists of a high "Q" resonant cavity adjustable over a frequency range of 9,170 to 9,445 Mc/s, directly calibrated in Mc/s., and a calibrated piston attenuator coupled direct to the cavity. A crystal detector coupled to the cavity detects the resonance and the crystal current deflects the tuning meter. For connecting to the directional coupler, a lossy coaxial cable is provided, having a socket at one end and a waveguide-to-coaxial transformer at the other.

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Unbalanced "pi" type 600Ω Attenuator switches consisting of 21-step stud switch and wire wound resistances. Switch provides 5 time impedance steps of 4dB and intermediate 1 dB steps, giving the overall range of 0 to 20 dB at 1 dB steps. Panel mounting, fully screened. ¼in. spindle. Barrel dimensions 2¼in. dia. × 3in. long, **10/-**, p.p. 2/-.

MARCONI TF338B VARIABLE ATTENUATOR

Characteristic impedance 600Ω. Internal/external termination. Range 0 to 105 dB obtainable by means of slidewire attenuator 0-25 dB and 4 steps of 20 dB each. Frequency response 0 to 100 kc/s £20 0 0

POWER UNITS

TYPE 234. 19in. rack mounted fully smoothed and fused for 230 v. A.C. input. H.T. output adjustable from 160 v. to 270 v. at 80 mA. by means of primary taps and high-low switch in the secondary winding. L.T. output 6.3 v. A.C. at 4 amps. Fitted with M.I. meter to read A.C. input and D.C. output volts. Secondhand, tested, in good condition. £3 19 6

DITTO, model without meter £3 10 0

Packing and carriage 15/-.

TYPE E.H.T. Input 200-250 v. A.C. Output 1,200 v. D.C. at 200 mA., fully smoothed. Rectifies by means of metal rectifier. On-off relays. Floor mounted. Weight 112 lb. Fully tested and guaranteed £18 0 0

Packing and carriage £1/10/-.

METERS
PHILIPS FIRST-CLASS MIRROR SCALE 1 mA. D.C. MC METERS

Square flange 4.6in. × 4.6in. flush mounted. Scale length 4in. Body 3.8in. dia. × 1⅞in. deep. Calibrated 0 to 1 mA. Price 65/-

VACUUM (GLASS ENVELOPE) DELAY RELAY. Type 6-030

OCTAL Base 6 v. Sotec supplies, nominal delay 30 sec., 5 amps. capacity "Make" contact, 8/- ea.

TRANSISTOR TESTER MODEL AT-1

For P-N-P and N-P-N Transistors.

Measures I_{CO} and diode reverse current up to 50μA for low power transistors and up to 1 mA for power transistors. B from 2 to 500 at 1 mA. for low power and 5 mA. for power transistors. Powered by dry cells. **£10/10/0.** p.p. 5/6.

VARIABLE AUTO-TRANSFORMERS

Input Voltage 230 v. A.C.: output variable from 0 to 260 v.

Type B2, 2.5 amps. **£5/19/6.** p.p. 7/6.

Type 02, unshrouded, 2.5 amps. **£3/10/-**, p.p. 7/-.

Type SB5, 5 amps. **£9**, p.p. 10/-.

Type SB20, 20 amps. **£32/10/-**, p.p. 15/-.

TYPE SB10—illustrated above, 10 amps. with protecting fuse. **£18** 5/-, p.p. 12/6.

R.F.T. TYPE FZ1-2 FREQUENCY INDICATOR

Portable Mains operated Frequency Indicator for direct measurements of frequencies from 10 c/s. to 100 kc/s. The range is covered in 8 bands, the lowest being 30 c/s. F.S.D. Measurement accuracy ±3% F.S.D. Input Impedance 100 kΩ. The instrument is provided with internal source of highly stable frequency for checking and recalibration of the scale. PRICE, new £20. Packing and carriage 15/-.

MULLARD E7555/2 VALVE VOLTMETER

The voltmeter measures D.C. and peak A.C. voltages in the following ranges: .5-1.5-5-15-50-150-500-1,500-5,000-15,000 v. Frequency response with probe (up to 50 v. peak) 100 mc/s.; without probe (up to 500 v. peak), 5 mc/s. From 500 v. to 15 kV. peak 50 c/s. only.

Accuracy up to 500 v. D.C. ±2% F.S.D. 500 v. to 15 kV. D.C. ±5% F.S.D. Up to 500 v. pk. A.C. ±3% F.S.D. 500 v.-15 kV. pk. A.C. ±7% F.S.D.

Power supplies 115/230 v. A.C., 45-60 cycles. PRICE, new and guaranteed, complete with probe, E.H.T. lead and manual £25 0 0

Packing and carriage 15/-.

MARCONI TF801 SERIES SIGNAL GENERATORS

TF801A. Frequency range 10-300 mc/s. in four overlapping bands. Calibration accuracy ±1%. Output 200 mV. max into 75Ω. Calibrated stepped attenuator 0 to — 100 dB. in 1 dB. steps. Internal sinewave (up to 80%) and square wave (50-50) modulation at 400-1,000-5,000 c/s. Provision for external modulation. Power requirements 100-130 and 200-260 v. A.C. Fully overhauled and guaranteed **£85** 0 0

TF801A/1. Generally as above, but with frequency range extended to 310 mc/s. and with provision of a separate "high" output socket giving unmonitored output of at least 1v.

Fully overhauled and guaranteed £115 0 0

Packing and carriage £1/10/-.

HEADPHONES

DLR3 Balanced Armature headsets, low impedance, **10/-**, p.p. 2/-. Moving coil headset fitted with large rubberized noise-excluding earpads, complete with moving coil microphone with switch. Low impedance. Steel neckband and canvas adjustable headband. Headset and Armature with army type 5-pointe moulded connector. **15/-**, p.p. 3/6.

CHR High impedance headsets with adjustable steel headband. D.C. Resistance at 400Ω. **15/-**, p.p. 2/6.

POST OFFICE TYPE ELECTRO-MAGNETIC COUNTERS

4-digit non-cancelling type Standard, 1½ × 1½ × 6in., 2,300Ω coil, secondhand 5/-

Miniature 1 × 1 × 3½in., available in 500Ω and 2,300Ω coils. Secondhand 6/6

Miniature 1 × 1 × 3½in., 4.1Ω coil, 6 v. operation, new.. 8/6

EX-AIR MINISTRY DIMMER SWITCHES

100 ohms 24 volts, **6/-** per dozen. P.P. 1/-.

R.P.M. INDICATOR KIT

Radio-Altimeter Indicators with moving coil movement of 5 mA. F.S.D., easily convertible to accurate engine R.P.M. indicators. Supplied complete with parts required for conversion, and detailed instructions. Suitable for 4-cylinder engines with 12v. electrical installation **35/-** P. & P. 5/-.

TRANSISTOR CIRCUIT COMPONENTS

Set of three 450 kc/s. I.F. Coils **10/6**

Variable Twin Gang Miniature Tuning Capacitor, two section, 4-165 pF. and 3-65 pF., with 1-8 pF. trimmer, complete with Broadcast Band Oscillator Coil **6/6**

Driver Transformer, impedance ratio 2 : 1 ..... **3/6**

Output Transformer for push-pull output, 250 mW... **3/6**

5000Ω Edgewise volume control with switch **4/9**

Packing and carriage 1/5 per item.

CATHODE RAY TUBES

401A (CV1522-VCR522); 1½in. General Purpose Oscilloscope Tube 50/-

408A (CV2265); 1½in. Blue Trace (Photographic)..... **60/-**

408C (CV2211); 1½in. Close Tolerance High Brightness Blue Trace (Photographic) with P.D.A..... **60/-**

1601G (CV4027); Rectangular 6in. × 2in. General Purpose Tube **160/-**

1601A (ACR13); 6in. General Purpose Oscilloscope Tube **80/-**

Packing and postage 5/- per tube.

4EP1; 4in. General Purpose Oscilloscope Tube..... **100/-**

DG13/2, 5in. General Purpose Oscilloscope Tube with P.D.A. **80-**

DG13/34 (5ADP1) similar to DG13/2 but with higher sensitivity **220-**

DG14/22 5½in. × 1½in. Rectangular Oscilloscope Tube .. 200/-

5WW—156 FOR FURTHER DETAILS.

TRANSISTORS

2N410	3/6	JTX4B	8/-	OC76	6/-
2N412	3/6	MAT101	8/6	OC77	8/-
2N697	15/-	MAT121	8/6	OC78	7/-
28002	10/-	TI166	6/-	OC78D	7/-
28004	10/-	OC16	40/-	OC81M	7/-
28005	15/-	OC24	22/6	OC81DM	7/-
28006	20/-	OC26	8/-	OC83	6/-
AF114	9/-	OC28	17/6	OC139	12/-
AF115	8/6	OC29	17/6	OC140	19/6
AF116	8/-	OC35	15/6	OC170	8/-
AF117	7/6	OC36	15/-	OC171	9/-
AF118	17/6	OC42	8/-	OC200	10/6
GET114	5/6	OC44	6/-	OC201	20/-
GET115	7/-	OC45	6/-	OC202	15/-
GET116	15/-	OC70	5/-	OC203	14/-
GET573	20/-	OC71	5/-	OC204	20/-
GET875	9/-	OC72	8/-	OC205	22/6
GET880	12/6	OC73	11/-	OC206	22/6
JTX4A	6/-	OC75	6/-	V30/30P	20/-

ZENER DIODES

½ watt: OAZ200 10/-; OAZ201 9/6; OAZ202 6/-; OAZ203 7/-; OAZ204 6/6; OAZ205 6/-; OAZ206 8/-; OAZ208 6/-; OAZ210 6/-; OAZ211 5/6; OAZ213 6/6; Z8.2 6/6; K844B (12.0V) 8/-.
2½ watt: VR425, VR475, VR575, VR7B, VR9B—all at 6/6.
5½ watt V10A, VR11A—all at 8/-.

SILICON JUNCTION RECTIFIERS

SJ102A, 100 piv/2.4A	7/6	IS004, 600 piv/.75A..	7/-
SX631, 100 piv/.75A	4/-	BY100, 700 piv/.45A	7/-
BYZ13, 200 piv/6A ..	10/-	OA211, 800 piv/.4A..	9/6
DD0066, 400 piv/.5A	6/6	DD058, 800 piv/.5A ..	12/6
OA210, 400 piv/.5A	6/6	BYZ10, 800 piv/6A ..	7/6
SX634, 400 piv/.75A	7/-		

SPECIAL OFFER: Unmarked Rectifiers, metal encapsulated, wire ended, 800 p.i.v. 500 made. 5/- each. £2/10/- per doz.

GERMANIUM POINT CONTACT DIODES

OA5	4/6	OA79	2/3	OA86	3/6
OA6	4/6	OA81	2-	OA90	2/-
OA70	2/-	OA85	3/-	OA91	2/3
OA73	1/6			OA95	3/-

GERMANIUM JUNCTION RECTIFIERS

GJ3M, 200piv., 400/800 mA; GJ5M, 300piv., 400/800 mA; GJ7M, 80 piv., 500/1000 mA—all at 3/6.
(Higher rating refer to coding fin mounting.)
Set of four of one type, 12/-.

PHOTOMULTIPLIERS

EMI 6094B	£20	Dumont 6292..	£17 10 0
EMI 6095B	£20	RCA 6328	£3 0 0
EMI 6097C	£30	RCA 6342	£5 0 0
EMI 9009B	£25	EMI 9514B	£30 0 0
EMI 9266B	£25	EMI 9530B	£30 0 0
EMI 6262	£30		

Please write for full details.

0A2	6/-	4THA	10/-	6D3	7/6	7E5	5/-	14Q7	10/-	250TH	220/-	5680	500/-	6621	10/-
0A3	11/-	5B/250M		6D4	15/-	7E6	4/-	15E	8/-	262B	30/-	5684	80/-	6939	45/-
0A4G	17/6		35/-	6D6	3/-	7E7	10/-	19AQ5	5/-	313C	30/-	5691	25/-	7044	10/-
0B2	8/-	5RAGY	9/-	6DK6	6/-	7F8	6/6	19BG6G	7/-	416B	200/-	5693	20/-	7289	100/-
0B3	6/-	5T4	8/-	6D84	15/-	7H7	8/-	19E2	20/-	417A	65/-	5696	6/-	7551	30/-
0C3	6/-	5U4G	5/-	6E5	7/-	7J7	14/-	19G3	25/-	450TL		5718	7/6	7586	22/6
0D3	5/-	5U4GB	6/6	6EA8	10/-	7Q7	9/-	19G6	15/-		300/-	5725	10/-	7895	22/6
0Z4	5/-	5V4G	8/-	6EV5	12-	7R7	12/-	20F2	15/-	583	40/-	5726	7/-	8103A	25/-
1A3	3/-	5V3GT	5/-	6F6	8/-	7Y4	7/-	20L1	14/-	705A	10/-	5727	10/-	8020	12/6
1A5GT	5/-	5Z4GT	8/-	6F6G	5/-	7Z4	5/-	20P1	14/-	715A	30/-	5750	11/-	8025	100/-
1A7GT	8/-	6/30L2	10/-	6F7	5/-	8D2	3/6	20P3	12/-	715B	60/-	5751	11/-	9001	4/-
1AD4	7/-	6A3	8/-	6F8G	5/-	9BW6	7/-	20P4	14/-	721B	25/-	5763	10/-	9002	5/6
1B3GT	7/-	6A6	4/-	6F11	6/-	9D7	7/-	20P5	12/-	801A	8/-	5783	WB5/6	9003	9/-
1B24	30/-	6A7	10/-	6F13	6/6	10C1	10/-	25A6G	5/-	803	30/-	5787	10/-	9004	2/6
1B24A	60/-	6A8	8/-	6F17	6/-	10C2	12/-	25L6GT	8/-	807	9/-	5814A	10/-	9006	2/6
1B27	40/-	6AB4	6/6	6F23	9/6	10D1	7/-	25Z4G	7/-	809	40/-	5840	10/-	A1714	25/-
1B59	45/-	6AB7	4/-	6F24	11/-	10F1	14-	25Z5	7/6	811	20/-	5842	65/-	A1834	22/6
1C5GT	7/-	6AC7	3/-	6F25	11/-	10F3	8/-	25Z6GT	8/6	813	70/-	5845	30/-	A2134	8/-
1D5GP	8/-	6AF4	11/-	6F27	10/-	10F9	9/-	27M1	60/-	814	20/-	5852	20/-	A2226	18/-
1D6	8/-	6AG5	2/6	6F28	10/-	10F18	10/-	28D7	7/-	815	40/-	5853	300/-	A2293	15/6
1H4G	6/-	6AG7	6/-	6F32	3/-	10L1	7/6	28D7W	15/-	832	20/-	5881	17/6	AC/HI/DD	
1H5GT	7/-	6AH6	10/-	6G6G	2/6	10LD11	10/-	29C1	20/-	832A	45/-	5965	5/-		8/-
1L4	2/-	6AJ5	9/-	6H1	7/-	10P13	12/6	30	4/-	838	12/-	5993	15/-	AC/THI	
1L6	17/-	6AK5	5/6	6H6	1/6	10P14	13/-	30A5	8/-	866A	14/-	6021	12/-		10/-
1N5GT	8/-	6AK5W	8/-	6J4	9/-	10Y	15/-	30C15	10/-	884	15/-	6057	10/-	AC/P4	4/-
1P21	120/-	6AK6	7/-	6J5GT	4/6	11D3	7/-	30C17	12/-	929	20/-	6058	7/-	AC4/PEN	
1Q5GT	8/-	6AK7	6/-	6J5G	4/-	11D5	7/-	30C18	10/6	930	30/-	6059	17/-		7/6
1R4	6/-	6AL5	3/-	6J6	3/6	11E2	15/-	30F5	9/-	931A	60/-	6060	6/-	AC5/PEN	
1R5	5/-	6AM5	2/6	6J7	9/-	11E3	35/-	30FL1	12/-	954	5/-	6061	12/-		12/6
1S4	5/-	6AM6	4/-	6J7G	5/-	12A6	3/-	30FL2	12/-	955	3/-	6064	8/-	AC5/PEN	
1S5	4/6	6AN5	10/-	6J7GT	7/6	12A8GT	5/-	30L15	12/-	956	2/-	6067	10/-	DD	8/-
1T4	3/-	6AN8	10/-	6K6GT	6/-	12AC6	8/-	30L17	13/-	957	55/-	6073	7/6	AC6/PEN	
1T5GT	6/-	6AQ5	6/-	6K7	5/-	12AH7GT		30P12	10/-	958	4/-	6080	25/-		6/-
1U4	5/-	6AQ8	8/-	6K7G	2/-		5/-	30P19	14/-	959	8/-	6094	25/-	ACT6	170/-
1U5	6/-	6AR5	6/-	6K7GT	5/-	12AH8	11/-	30PL1	10/6	991	7/-	6098	12/-	ACT22	
1V	5/-	6AR6	6/-	6K8	8/-	12AL5	7/-	30PL13	11/-	1625	6/-	6100	10/-		240/-
1X2A	7/-	6AR8	17/6	6K8G	4/-	12AQ5	7/-	30PL14	12/6	1626	3/-	6101	7/-	AH211A	
1X2B	7/-	6AS6	5/-	6K8GT	8/-	12AT6	5/-	32	8/-	1635	12/-	6111	15/-		240/-
2A3	5/-	6AS7G	22/6	6K25	24/-	12AT7	4/-	35A5	11/-	2050	12/6	6130	30/-	AR8	6/-
2A4G	30/-	6AT6	4/-	6L1	10/-	12AT7WA		35C5	6/6	2051	6/-	6135	10/-	ARP3	3/-
2C26	3/-	6AU6	6/-	6L6GA	7/6		6/-	35L6GT	7/-	4019A	25/-	6136	9/-	ARP12	3/6
2C34	4/-	6AV6	6/-	6L6WGB		12AU6	6/-	35T	40/-	4033A	15/-	6140	30/-	ATP4	5/-
2C42	25/-	6AW8A			17/6	12AU7	5/-	35W4	5/-	4043C	25/-	6146	27/6	AW6	5/-
2C46	30/-		14/-	6L7	5/-	12AV6	6-	35Z3	10/-	4069A	60/-	6147	17/-	AZ1	9/-
2C51	12/-	6AX5GT		6L18	8/-	12AV7	8/-	35Z4G	4/-	4242A	30/-	6159	32/-	AZ12	9/-
2C52	12/-		12/6	6N7GT	6/-	12AX7	6/-	35Z4GT	6/-	4387	17/6	6161	300/-	AZ41	6/6
2C53	60/-	6B7	5/-	6P1	11/-	12AY7	10/-	35Z5GT	6/-	5514	50/-	6186	10/-	B36	15/-
2CW4	12/-	6B8G	2/6	6P25	12/8	12B4A	9/-	38	5/-	5517	6/-	6189	10/-	B65	4/6
2D21	6/-	6BA6	4/9	6Q7GT	8/-	12BA6	6/-	41	5/-	5557	80/-	6197	20/-	BD78	45/-
2E24	40/-	6BA7	15/-	6R7	6/-	12BE6	5/-	42	5/-	5559	50/-	6202	8/-	BL63	10/-
2E26	30/-	6BC4	17/6	6SA7	8/-	12BH7	8/-	431U	8/-	5626	120/-	6205	10/-	B84A	30/-
2G21	12/-	6BE6	5/-	6S7	9/-	12BY7	10/-	50A5	12/-	5636	10/-	6211	4/6	B890	40/-
2X2	3/-	6BF6	6/-	6S7G	6/-	50B5	7/-	50C5	6/6	5641	12/6	6263	70/-	B8104	400/-
2X2A	7/-	6BH6	7/-	6SH7	3/-	12E1	20/-	50CD6G		5651	8/-	6280	200/-	BT5	50/-
3A/141A		6BJ6	8/-	6SJ7	5/-	12F5GT	8/-			5654	8/-	6293	30/-	BT9A	60/-
	35/-	6BJ7	7/-	6SK7	5/-	12H6	3/-		25/-	5663	7/-	6336	80/-	BT19	30/-
3A4	4/-	6BK4	20/-	6SL7GT	5/-	12J5GT	3/-	50L6GT	6/6	5665	200/-	6350	4/-	BT45	200/-
3A5	7/-	6BK7A	8/-	6SN7GT	4/6	12J5WGT		75B1	5/6	5670	10/-	6442	100/-	BT79	30/-
3B7	5/-	6BL7GT	9/-	6S87	3/-		6/-	76	5/-	5672	7/-	6463	7/-	BT83	60/-
3B22	30/-	6BN6	7/-	6U4GT	10/6	12J7GT	7/6	77	5/-	5676	10/-	6550	30/-	CBL1	15/-
3B24	5/-	6BQ7A	8/-	6U5	8/-	12K7GT	7/-	78	5/-	4019A	25/-	D1	3/-	CBL31	16/-
3B24W	12/-	6BR7	11/6	6U7G	7/-	12K8	10/-	80	6/-	4033A	15/-			CL33	9/-
3C45	30/-	6BR8	5/-	6U8	7/6	12Q7GT	5/-	808	9/-	4043C	25/-			CY31	6/6
3CX100A5		6BW6	9/-	6V6	9/-	12SA7	7/-	813	10/-	4069A	60/-			D1	3/-
	100/-	6BW7	9/-	6V6G	5/-	12SC7	4/-	829	8/-	4242A	30/-				
3D6	4/-	6C4	2/6	6V6GT	7/6	12SF5GT		832	8/-	4387	17/6				
3E29	60/-	6C5GT	6/-	6X4	4/-		9/-	834	8/-	5514	50/-				
3Q4	6/6	6C5GT	5/6	6X5GT	5/6	12SG7		845	25/-	5517	6/-				
3Q5GT	6/6	6C6	4/-	6Z3	4/-		4/-	85A1	25/-	5557	80/-				
3S4	5/-	6C8G	7/-	6Z4	5/-	12SH7	4/-	85A2	8/6	5559	50/-				
3V4	5/6	6C21	100/-	7B6	11/-	12SJ7	4/-	85A3	5/6	5626	120/-				
4-125A		6C31	12/-	7B7	8/-	12SK7	5/-	90AG	25/-	5636	10/-				
	160/-	6CB6	5/-	7B8	8/-	12SL7GT		90AV	15/-	5641	12/6				
4-250A		6CD6GA		7C5	10/-		7/6	90CG	20/-	5651	8/-				
	220/-		17/-	7C6	7/-	12SN7GT		90CV	17/6	5654	8/-				
4C35	140/-	6CH6	6/-	7C7	5/-		7/6	100TH	60/-	5663	7/-				
4CX250B		6CL6	9/-	7D3	8/-	12SR7	5/-	150B2	12/-	5665	200/-				
	200/-	6CW4	12/-	7D5	8/-	12SY7	6/-	150B3	8/-	5670	10/-				
4D1	4/-	6CY5	10/-	7D8	7/-	12Y4	2/6	211	30/-	5672	7/-				
						13D1	5/-	225DU	10/-	5676	10/-				
						13D3	6/-								

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TOP QUALITY VALVES

DA30	10/-	ECC84	6/6	FW4/800		PCL81	9/-	TTR31	60/-						
DA41	40/-	ECC85	6/6		8/6	PCL82	7/-	TZ40	40/-						
DAC32	7/-	ECC88	10/-	G10/241M		PCL83	8/3	U22/14	5/-						
DAF70	7/-	ECF80	7/6		80/-	PCL84	8/-	U17	5/-						
DAF91	4/6	ECF82	7/6	HABC80	8/-	PCL85	9/-	U22	6/-						
DAF92	6/-	ECF88	10/-	HL2	3/-	PCL86	9/-	U25	11/-						
DAF96	6/-	ECH21	10/-	HL2K	3/-	PEN4A	7/6	U26	11/-						
DC70	8/-	ECH35	13/-	HL23	6/-	PEN45	7/-	U50	5/-						
DCC90	7/-	ECH42	8/-	HL23DD		PEN45DD		U76	4/-						
DET5	10/-	ECH81	6/-		6/-		12/-	U191	11/-						
DET18	40/-	ECL80	6/6	HL133DD		PEN46	6/-	U251	12/6						
DET24	70/-	ECL82	7/6		10/-	PEN220A		U281	13/-						
DET25	15/-	ECL83	9/-	HR2	15/-		7/-	U282	14/-						
DF33	8/-	ECL86	8/6	GC10/4B		PEN383		U301	12/-						
DF91	3/-	EF36	4/6		20/-		12/-	U403	7/-						
DF92	2/6	EF37A	8/-	GEX23	1/6	PEN384		U801	18/-						
DF96	6/-	EF39	5/-	GEX54	2/-		12/-	U4020	7/6						
DH63	6/-	EF40	9/-	GM5	25/-	PEN453DD		UABC80							
DK32	8/-	EF41	7/6	GT1C	10/-		10/6		6/-						
DK40	11/-	EF42	6/-	GT3	15/-	PF86	7/6	UAF42	8/-						
DK91	5/-	EF54	6/-	GU50	25/-	PL36	10/-	UBC41	7/-						
DK96	7/6	EF55	8/-	GZ30	8/6	PL38	16/-	UBC81	7/-						
DL66	12/-	EF80	5/-	GZ32	10/-	PL81	7/-	UBF80	6/6						
DL68	10/-	EF85	6/-	GZ34	10/-	PL82	6/-	UBF89	7/-						
DL69	12/6	EF86	7/-	GZ37	14/-	PL83	6/6	UBL21	11/-						
DL70	7/-	EF89	4/6	HR7	15/-	PL84	6/6	UCC84	9/-						
DL73	12/-	EF91	4/-	KT8C	20/-	PL500	15/-	UCC85	7/-						
DL74	10/-	EF93	4/9	KT41	7/6	PM84	10/-	UCF89	9/6						
DL75	10/-	EF94	6/-	KT44	5/-	PT15	10/-	UCH21	8/6						
DL92	5/-	EF95	5/6	KT61	12/6	PY31	7/-	UCH42	8/-						
DL93	4/-	EF98	10/-	KT63	6/-	PY33	9/-	UCH81	7/-						
DL94	5/6	EF183	8/-	KT66	15/-	PY81	6/-	UCL82	8/-						
DL95	6/6	EF184	8/-	KT88	20/-	PY82	6/-	UCL83	10/-						
DL96	6/6	EFP60	10/-	KTW62	7/-	PY83	6/-	UF41	7/6						
DL816	20/-	EL32	3/-	LP2	7/6	PY88	8/6	UF42	8/-						
DM70	5/-	EL34	10/-	ME91	7/6	PY800	8/6	UF43	8/-						
DY30	5/-	EL35	5/-	ME1403		PY801	8/6	UF80	6/6						
DY80	7/-	EL36	9/-		40/-	PX4	15/-	UF85	7/-						
DY86	8/-	EL37	17/6	MH4	5/-	PX25	10/-	UF86	10/-						
DY87	9/-	EL38	17/6	MHLD6		PZ30	10/-	UF89	6/-						
E1T	55/-	EL41	8/-		12/6	QP40	60/-	UL41	8/-						
E88CC	14/-	EL42	9/-	ML6	6/-	QP25	5/-	UL84	6/6						
E90CC	12/-	EL81	8/6	M8PENT		QQVO2-6		UM4	10/-						
E91H	12/-	EL83	7/-		10/-		45/-	UM80	7/-						
E92CC	7/-	EL84	5/-	MT17	80/-	QQVO3-10		UU5	8/-						
E180CC	8/-	EL85	8/-	MT37	80/-		35/-	UU7	8/-						
E180F	15/-	EL86	7/6	MU12/14		QQVO3-20A		UU9	7/-						
EA50	2/-	EL90	6/-		8/-		100/-	UU10	8/-						
EA52	80/-	EL91	2/6	N78	15/-	QS105/45		UY1N	10/-						
EA76	8/6	EL360	22/-	NR88	12/6		15/-	UY21	8/-						
EABC80	7/-	EL821	6/-	N8P1	25/-	QV04-7		UY41	6/-						
EAC91	4/-	EM4	10/-	N8P2	22/-		10/-	UY85	5/6						
EAF42	8/6	EM31	5/-	OCP71	24/-	QY3-125		VGT121							
EB41	5/-	EM34	9/6	ORP12	12/-		160/-		15/-						
EBC33	7/-	EM80	6/6	ORP60	10/-	R2	8/-	VGT128							
EBC41	7/-	EM81	7/6	P41	8/-	R10	15/-		10/-						
EBC81	6/6	EM84	8/-	P61	3/-	R17	8/-	VP23	3/6						
EBF80	6/6	EM87	7/-	PABC80		R18	7/6	VP41	5/-						
EBF83	7/6	EN31	10/-		7/-	R19	7/-	VR78	3/-						
EBF89	6/9	EN32	10/-	PC86	12/-	RG3-1250		VT4C	30/-						
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EC52	12/6	EY81	8/-	PCC84	6/-		80/-	W21	5/-						
EC53	12/6	EY83	9/6	PCC85	7/-	RL18	12/6	W81M	6/-						
EC88	12/-	EY84	7/6	PCC88	12/-	S130	11/6	X65	5/6						
EC90	2/6	EY86	6/6	PCC89	11/-	SP42	8/-	X66	8/-						
EC91	5/-	EZ35	5/6	PCC189		SP61	4/-	X78	20/-						
EC92	6/6	EZ40	6/-		10/-	TH41	10/-	X79	20/-						
ECC31	5/-	EZ41	6/6	PCF80	7/-	TH233	6/-	XB1	12/6						
ECC32	4/-	EZ80	5/6	PCF82	7/6	TH2321	7/-	XC11	12/6						
ECC33	8/-	EZ81	4/6	PCF84	8/-	TP22	5/-	XR1-3200							
ECC35	7/-	FA15	120/-	PCF86	9/-	TP25	5/-		120/-						
ECC40	9/-	FVD7	15/-	PCF801		TP2620	7/6	Z66	10/-						
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ECC82	5/-		7/-	PCF802		TT15	35/-	Z700U	4/-						
ECC83	6/-				10/-	TT21	32/-	Z760U	4/-						
				PCF805		TT22	32/-	Z759	22/-						
					10/6			Z800U	20/-						
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Please send all correspondence and Mail Orders to ADDRESS OF HEAD OFFICE AT

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5WW—157 FOR FURTHER DETAILS.

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Multicore
SOLDER

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PRINTED CIRCUIT & TRANSISTOR SOLDER

Designed specifically for Printed Circuits and High Temperature Sensitive Components. Plastic re-usable reel contains 212 feet of 60/40 High Tin Quality 22 s.w.g. ERSIN MULTICORE SOLDER with 5-cores of non-corrosive flux. Ask for Size 10.

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Complete with Razor Cutter 18/6

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BERRY'S RADIO

THE HOUSE FOR THE BEST & NEWEST IN HI-FI, TAPE & ELECTRONIC EQUIPMENT
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Electrolytic Capacitors
* Electronic Flash
* Energy Storage
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DALY

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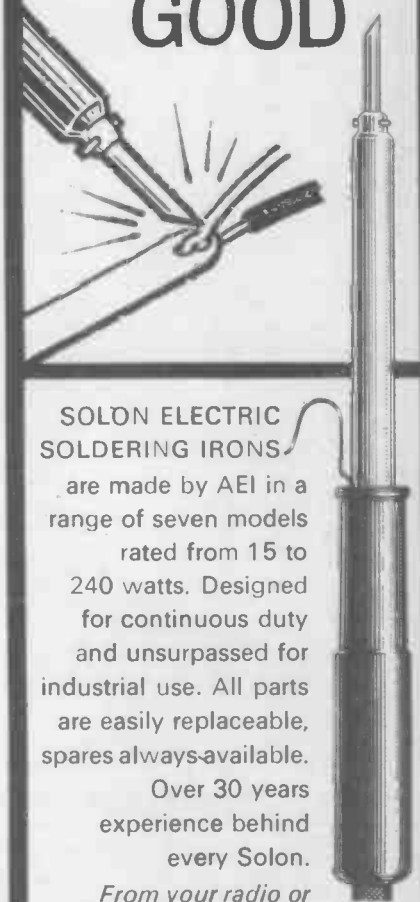
SOLON GETS THINGS TOGETHER FOR GOOD



SOLON ELECTRIC SOLDERING IRONS are made by AEI in a range of seven models rated from 15 to 240 watts. Designed for continuous duty and unsurpassed for industrial use. All parts are easily replaceable, spares always available. Over 30 years experience behind every Solon.

From your radio or electrical supplier

SOLON TRADE MARK

5WW—162 FOR FURTHER DETAILS. 11/75/c

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DISPLAYED: £5 per single col. inch.
LINE advertisements (run-on): 5/6 per line (approx. 7 words), minimum two lines.
Where an advertisement includes a box number (count as 2 words) there is an additional charge of 1/-.
SERIES DISCOUNT: 15% is allowed on orders for twelve monthly insertions provided a contract is placed in advance.
BOX NUMBERS: Replies should be addressed to the Box number in the advertisement, c/o Wireless World, Dorset House, Stamford Street, London, S.E.1.
No responsibility accepted for errors.

Advertisements accepted up to 9th MAY for the JUNE issue, Subject to space being available.

SITUATIONS VACANT

ENGINEER Technicians.
DIPLOMATIC Wireless Service.
THE Diplomatic Wireless Service have vacancies for about 25 pensionable posts in (a) Grade I, (b) Grade II, (c) Grade III.
THIS Department operates a world-wide network of Radio Communication Stations which is in the process of being modernised and expanded and the most up-to-date techniques in radio teleprinter systems are being employed. The duties of Engineers in this field involve installation, modification, maintenance and operation of radio transmitters and receivers of the most modern types, remotely tuned aerial systems, teleprinter and voice frequency telegraph equipment. In addition several high-powered broadcasting stations relaying programmes in both the H.F. and the M.F. bands. The Transmitters involved include some of the highest powers yet produced for this purpose. The duties in this field include the installation, modifications, maintenance and operation of these very high-power transmitters, the most modern receiving equipment, tape recorders, diesel generating plant, etc. The Department's policy is to encourage versatility and to carry out as much installation and modification work as possible with its own staff. The initial appointments will be either to Crowborough, Sussex, or Hanslope, Bucks. Liability for service overseas.
QUALIFICATIONS: O.N.C. in Electrical or Mechanical Engineering or a City and Guilds Telecommunications, Electrical, or Mechanical Engineering Technician's Certificate (Nos. 49, 57 or 293). Equivalent qualifications may be accepted. Higher qualifications will be an advantage.
SALARY (national)t (a) £1,244-£1,532; (b) £1,091-£1,244; (c) £769 (at age 21)-£975 (at 28 or over)-£1,091. Promotion prospects.
WRITE (preferably by postcard) to Civil Service Commission, Savile Row, London, W.1, for application form quoting S/6111/65. Closing date 10th May 1965. [1199

AN OVERSEAS CAREER WITH
INTERNATIONAL AERADIO, LIMITED
TO meet the requirements of constant growth and expansion we invite applications from technicians and engineers for an overseas career in North, West and East Africa, the Mediterranean area, the Caribbean, the Arabian Gulf and the Far East. If you have recently completed service in a trade such as Ground Wireless Fitter in the R.A.F. or Radio Electrical Artificer in the Royal Navy or have other experience in the maintenance of HF and VHF communications, RTT and navigational aids, we should be interested to hear from you. Successful candidates would normally spend six weeks at our Radio Training School, Southall, Middlesex, before proceeding overseas, but in some cases staff with suitable qualifications and experience may be offered immediate posting. Overseas staff receive a tax-free salary with married and child allowances if appropriate and accommodation, bachelor or married, is provided free; other benefits include generous U.K. leave and membership of an excellent pension and life assurance scheme.
WRITTEN applications, please, to Personnel Officer, 40, Park St., W.1. [115

ASSISTANT EXECUTIVE ENGINEERS.
POST Office.
ABOUT 25 pensionable posts for men or women aged 17¼ and under 25 on 1/9/65 (with extension for Forces Service, Overseas Civil Service, and up to two years permanent Civil Service).
DUTIES: technical design and development of telecommunications equipment.
QUALIFICATIONS:
EITHER (i) G.C.E. (or equivalent) passes in English Language and four other subjects, including two at "A" level obtained at the same examination for Pure Mathematics, Applied Mathematics, Physics, Chemistry.
OR (ii) Higher National Diploma in Electrical or Mechanical Engineering or Applied Physics, or a pass in (or exemption from) Parts 1, 2 and 3 of the Graduateship Examination of I.E.E. or I.Mech.E., or a pass in (or exemption from) Sections A and B of the I.E.R.E. Graduateship Examination under the September 1962 Syllabus and Regulations.
CANDIDATES applying under (ii) must also have a G.C.E. (or equivalent) pass in English Language.
SALARY (Inner London): £740, at 18 £1,085, at 25 or over £1,575. Promotion prospects.
WRITE (preferably by postcard) to Civil Service Commission, Savile Row, London, W.1, for application form, quoting S/330/65. Closing date 6th May, 1965. [1187

TEST engineers.—Applications are invited from test engineers with previous industrial experience of testing radio communications, receivers and transmitters; successful applicants will be offered positions on the company's permanent staff; starting salaries commensurate with qualifications and experience.—Apply in writing, giving full details, to Personnel Officer, Redifon, Ltd., Bromhill Rd., S.W.18. [124

YORKSHIRE IMPERIAL

YORKSHIRE IMPERIAL METALS LIMITED

have two vacancies in their

ELECTRICAL ENGINEERING DEPARTMENT

1. **Electronic Maintenance Supervisor**
2. **Electronic Maintenance Technician**

The work will involve the maintenance, calibration and installation of a wide variety of industrial electronic equipment.

Applicants must have a knowledge of solid state circuiting for the supervisory post. Some experience is also desirable in one or more of the following fields:

1. Non destructive testing equipment
2. Machine Control
3. Communications

Consideration will also be given to men with experience of electronics in the Services.

The Company is the largest of its kind in Europe and offers attractive conditions of employment which include a Pension and Life Assurance Scheme and Profit Sharing Scheme.

Applications, giving details of age, experience, qualifications and present salary, should be marked " Reference 6168—Confidential " and addressed to:

The Personnel Officer (Leeds),
YORKSHIRE IMPERIAL METALS LIMITED,
P.O. BOX 166, LEEDS.

STC

RADIO TECHNICIANS

We require technicians at our London Airport Service Depot for work on a wide range of airborne radio equipments.

Applicants should have experience in the maintenance of radio or electronic apparatus. Experience in the airborne field desirable but not essential. Familiarity with modern techniques an advantage. These are staff positions.

Write in confidence to **Personnel Manager,**

Standard Telephones and Cables Limited

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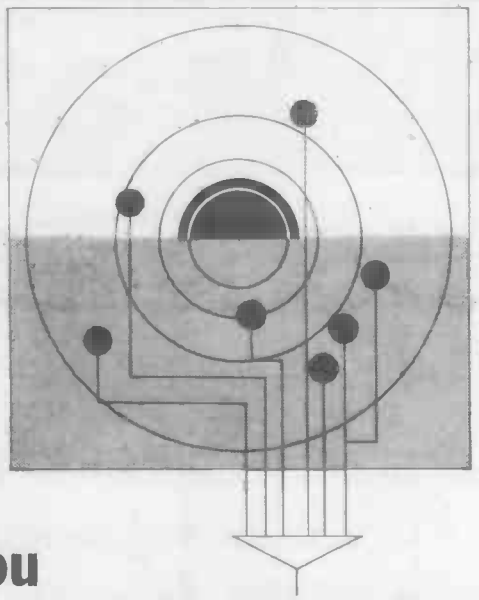

Could you trouble shoot a computer?

Keeping a computer working smoothly is only part of a Customer Engineer's job at IBM. He works with his customers (within daily reach of his home) in their offices, helping them to use the equipment more effectively. He meets all levels of customer management in different branches of commerce and industry. He should have the ability to produce fresh ideas and have confidence in his own judgment. He must be able to combine his engineering skill with an understanding of his customers' needs and business systems. The job is a challenge, so is any work worth doing. And it's never dull.

We offer a thorough training. Starting salaries are normally in the region of £1,000 a year, with special consideration for men with special aptitude or specific experience. Increases are on individual merit. As a Customer Engineer you could be earning between £1,250 and £1,700 in three years. Promotion also is on merit and from within the company.

Is this the kind of career you're looking for? If you are between 21 and 29 and have a working knowledge of electronics (e.g. through a Radar/radio Fitters Course, Telecommunications experience or ONC/HNC Electrical or Electronic) we'd like to discuss your plans with you and show you how they could be realised in our rapidly growing organisation.

If you're not quite old enough to have reached the standards we've indicated, we'd still like to hear from you. If you've just left school with 'A' level Maths and English or are studying for ONC Electrical Engineering, we invite you to apply to us. There could be a place for you.

Please send a summary of your education, experience, interests and age to Mr. I. F. Bush, IBM United Kingdom Limited, 101 Wigmore Street, London, W.1., quoting reference CE/WW/195.

You can grow with IBM

TESTERS

required for interesting work on L.F. and H.F. Transmitters. Previous fault-finding experience essential.

The positions available would be of special interest to persons employed in the fault-finding and repair of television who are keen to establish themselves in a position that offers:

- ★ Satisfactory employment
- ★ Five-day week
- ★ Good prospects of advancement
- ★ Staff status
- ★ Sick pay
- ★ Generous salary

Apply: Personnel Manager

Multitone Electric Co. Ltd.

12-20 Underwood St., London, N.1

RADIO Examiners—Ministry of Defence (Air Force Dept.).
A LARGE number of vacancies exist in the United Kingdom and abroad (and more will arise from time to time) in the Air Force Department for Examiners who are employed on the inspection and calibration of a wide range of electronic equipment.
QUALIFICATION.—Applicants must be British subjects. Holders of the O.N.C., City and Guilds or an equivalent certificate are preferred, but all applicants who have training and experience on Radio and/or Radar equipments and who are prepared to study for an appropriate technical certificate will be considered. Medical fitness for abroad is essential.
LOCATION of Posts at Henlow (Beds), Sealand (Chester), Carlisle (Cumb), Aldergrove (Northern Ireland) and various other R.A.F. stations in the United Kingdom. After first appointment all inspection staff are required to serve at any R.A.F. station at home or abroad. Housing is usually provided overseas for rent, and is sometimes available at a small number of stations in the United Kingdom.
PAY (increases under review): £769 at age 21 increasing by annual increments to maximum of £1,091. Age 28 and over start at £975. Extra pay and attractive allowances for overseas service.
PROSPECTS for Promotion to senior grades up to salary maximum of £1,928 (increases also pending) are good. Promotion by interview based on experience, qualifications and merit.
PROSPECTS for Pension also good. Temporary staff paid gratuity based on length of service if they retire or resign after five years' service. Established appointment (for pension and gratuity) can be obtained by passing Civil Service Commission interview once the O.N.C. or equivalent certificate is held.
STUDIES for O.N.C., H.N.C., etc., encouraged by release from work one day a week and by payment of fees, etc., by Department.
HOLIDAYS, Sickness, etc.—Five-day week. Annual holidays three weeks and three days at start increasing gradually to six weeks after 30 years. In addition, 8½ days public holidays a year. Sick leave benefits. Canteen facilities. Assisted travel at some stations.
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RADIO Engineers and Mechanics with specific workshop experience in ADF/HF, VHF or ILS/VOR. 40-hour week, salary according to experience and ability, pension scheme.—Apply: Managing Director, Air Transport (Charter) (C.I.), Ltd., Willow Rd., Poyle Trading Estate, Colnbrook, Bucks. [1182

PROFESSIONAL ENGINEERS AND TECHNICIANS

with at least two years' experience in British Industry are invited to avail themselves of our Confidential and Free Service.

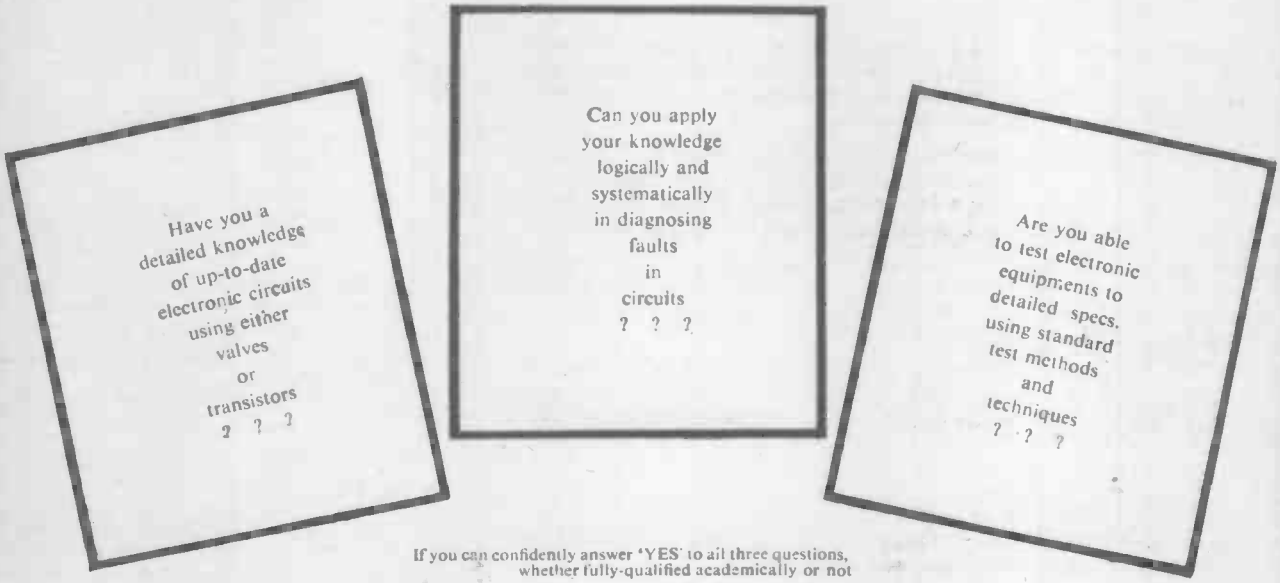
E.A.L. offers the most efficient and satisfactory way of obtaining alternative employment in the Electronics Industry.

E.A.L. is in contact with all firms in S.E. England and undertakes a complete and thorough survey of any area for suitable vacancies for every engineer registered with us.

For further information please phone or write to:

Electronics Appointments Ltd., 22 Gloucester Mns., Cambridge Circus, London, W.C.2
Phone: TEMple Bar 5557/8

TEST ENGINEERS


Have you a detailed knowledge of up-to-date electronic circuits using either valves or transistors ? ? ?
Can you apply your knowledge logically and systematically in diagnosing faults in circuits ? ? ?
Are you able to test electronic equipments to detailed specs. using standard test methods and techniques ? ? ?

If you can confidently answer 'YES' to all three questions, whether fully-qualified academically or not

then we can offer you

1 A permanent position on our weekly staff with a salary in the range £884 to £1,105 p.a.

2 Non contributory pension, life assurance and sickness cover.

3 Prospects of promotion to more senior positions based entirely on merit and ability.

vacancies occur at both our

CHESSINGTON AND FARNBOROUGH

locations

interested? ***then write to***

Personnel Officer,
THE SOLARTRON ELECTRONIC GROUP LTD.
Cox Lane, Chessington, Surrey.

or

Personnel Officer,
THE SOLARTRON ELECTRONIC GROUP LTD.
Victoria Road, Farnborough, Hants.

SOLARTRON **THE SOLARTRON ELECTRONIC GROUP LTD**

COMPUTER ENGINEERS
or
ELECTRONIC ENGINEERS

English Electric Leo Marconi invites applications for the following new openings:

Design Engineers for Test Equipment. There are several vacancies for qualified electronic engineers ranging from posts concerned with the design of printed circuit testing equipment to posts for engineers who have relevant computer experience.

Systems Test Engineers for the factory commissioning of Computers and Industrial Data Processing Equipment. Some vacancies are immediate—others are for a few months ahead. Electronic engineers who have logical ability or experience would be suitable applicants.

Test Equipment Engineer to organise the maintenance of factory-made and proprietary Test Equipment, including oscilloscopes and printed circuit testers. Experience is more important than qualifications and men in their thirties are invited to apply.

All the above openings are at Kidsgrove, which is well placed on the border of Cheshire and Staffordshire. Housing is relatively inexpensive and easy to find in town or country environments nearby. This is a good time to join the Company and young men with energy would find plenty of scope for challenging work.

Please write giving age, qualifications and experience to:

The Technical Staff Officer, Dept. WW/P.19, English Electric-Leo-Marconi Computers Ltd., Kidsgrove, Stoke-on-Trent.

ENGLISH ELECTRIC LEO MARCONI

TELEVISION ENGINEER (TRANSMITTER)

GOVERNMENT OF UGANDA

A Transmitter Engineer is required to take charge of the Marconi 5 K.W. vision transmitter and associated 1 K.W. sound transmitter at Kampala. The selected candidate will be in sole charge of the transmitting station under the Chief Engineer, will train and control a local staff of six, supervise the day to day running of the station, and prepare reports for the Chief Engineer. In addition he will maintain all sound and vision equipment and recommend on the maintenance of aerials tower, etc.

Candidates must have a good educational background with the Higher National City and Guilds full Technological Certificate and extensive practical experience in the operation and maintenance of modern vision and associated sound transmitters, and in the use of transmitter test equipment including side band analysers, also the ability to test and maintain a modern high power vision transmitter.

Candidates should preferably have practical experience of T.V. aerials filter plexers and associated equipment.

The appointment will be on contract for one/two tours of 21-27 months with salary in the scale £1,725 to £1,956 per annum plus gratuity of 25% of total emoluments. Free family passages. Free medical attention and furnished quarters provided at moderate rentals. Generous leave and education allowances.

Applicants who must be nationals of the United Kingdom or the Republic of Ireland should apply to the

MINISTRY OF OVERSEAS DEVELOPMENT,
Room 301,
Eland House,
Stag Place,
Victoria,
London, S.W.1.

giving qualifications, age, nationality and experience and quoting RC 237/182/02.

"WIRELESS WORLD"

An additional member is required for the editorial team producing *Wireless World*.

Applicants with radio or electronic engineering experience and an ability to write lucidly should send the editor details of education and experience in the fields covered by the journal.

Preferred age 25/35.

Wireless World,
Dorset House,
Stamford Street,
London, S.E.1.

RADIO & Television Testers.
FOR City Factory; good rates up to 7/6 per hour; five-day week.
APPLY to Personnel Manager:—
ALBA (RADIO & TELEVISION), Ltd., Tabernacle St., London, E.C.2. [105

EXECUTIVE Engineers, Post Office
PENSIONABLE posts in London and Provinces for mechanical, electrical and electronic engineers to develop and design communications systems and postal service equipment.
QUALIFICATIONS: Degree or Dip. Tech. in engineering or physics or, exceptionally, very high professional attainment. Final year students may apply.
SALARY (Inner London): £850-£1,748. Promotion prospects.
AGE: At least 21 and normally under 35 on 31.12.65. Some extensions for service in H.M. Forces or Overseas Civil Service. Write (preferably by postcard) to Civil Service Commission, Savile Row, London, W.1, quoting S/322. [1195

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ENGINEER

to instal & maintain wired T.V. system —share given if capital available— suitable H.N.C., aged 25/35.

Box. No. 5014 c/o "Wireless World"

ELECTRONICS development staff.
IMPERIAL College, London, S.W.7.
WE have technical staff vacancies for interesting and varied duties in the construction and maintenance of the most modern electronic equipment used in our research programmes. If you have a good practical knowledge of electronics or are a young man working for ONC or HNC, write to me giving full details of your education and career to date. Information about vacant posts in the salary range £630-£1,135 will then be sent to you.
PROFESSOR G. R. Hall, Department of Chemical Engineering and Chemical Technology, Imperial College, London, S.W.7. [1202

AGRICULTURAL Research Council.
FOOD RESEARCH.
EXPERIENCED Electronics Technician required in Norwich, initially to run an electronic workshop at the Earlham Food Research Laboratory, then to take charge of a similar workshop at the new Food Research Institute which is to be completed in late 1967.
QUALIFICATIONS: HNC or similar qualification in electronics.
SALARY: According to age and experience either on Experimental Officer Grade (£1,319-£1,675) or Technical and Works Grade I (£1,244-£1,532).
APPLICATIONS (quoting ref. 65/1) with names and addresses of 3 referees to.—Secretary, Low Temperature Research Station, Downing St., Cambridge. [1197

SYSTEMS DESIGN ENGINEERS

PYE TELECOMMUNICATIONS

require:

SYSTEMS ENGINEERS FOR THE DESIGN OF CONTROL SYSTEMS FOR USE WITH RADIO COMMUNICATIONS NETWORKS

Applicants must be experienced in the design and maintenance of telephone switching equipment or multi-channel telephone systems and be familiar with the principles involved.

Experience of the application of such systems to radio bearer circuits is desirable but not essential.

Corporate membership of the I.E.E. or equivalent is desirable but applicants without such qualifications who can prove wide experience up to a recent date will be considered.

Apply to: **Personnel Manager**
Pye Telecommunications Ltd.
Newmarket Road, Cambridge

THE MINISTRY OF DEFENCE (ARMY DEPARTMENT) invites applications for interesting Grade V ENGINEERING appointments in the BRITISH FORCES BROADCASTING SERVICE overseas in Aden, Benghazi, Tobruk, Tripoli and Cyprus.

DUTIES & QUALIFICATIONS

Operation and maintenance of MF, HF, VHF, Transmitters, Studio equipment and generating equipment. Appropriate ONC, City and Guilds, or equivalent qualifications are necessary.

SALARY SCALE (under review) for Grade V staff is £739 to £1,039 p.a. In addition generous non-taxable Foreign Service Allowances are paid according to location. Candidates must be at least 21 years of age.

For further details and Application Form please write to:—

The Director (EW),
British Forces Broadcasting Service,
Kings Buildings,
Dean Stanley Street,
London, S.W.1.

SMITHS

AVIATION DIVISION

SENIOR ELECTRONICS ENGINEERS FOR AIRCRAFT AND INDUSTRIAL PROJECTS

The work is very interesting and includes: low level analogue circuits using the latest components and packaging techniques.

Control systems using miniature electromechanical components.

Magnetic tape devices.

Automatic programming devices using digital techniques.

Applicants will preferably have a degree or H.N.C. in electrical/electronics engineering. They will have had some years' experience of original design work but not necessarily in the specified subjects.

Apply in writing, giving full particulars of experience, qualifications, age, present salary and salary envisaged to:

The Personnel Manager,
S. SMITH & SONS (ENGLAND) LTD.,
Aviation Division,
Bishops Cleeve,
Nr. Cheltenham.

Engineers and Technicians

with a good knowledge of tape-recorders, especially in the mechanical field, and engineers with knowledge of pick-ups and record-works are wanted.
Have you the above qualifications and are you full of ideas and constructive capacity; are you able to work out a construction thoroughly; are you hard-working so that you can keep to the plans which you yourself have helped to draw up—then you are the right man for the job.
We can offer you very interesting assignments, good working conditions and a good salary.
Please send a written application with all necessary information to the electroacoustic laboratory at

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Ingenieure und Techniker mit guten Kenntnissen zu Tonbandgeräten, besonders auf technischem Gebiet, und Ingenieure mit Erfahrung bei der Behandlung von Pick-ups und Grammophonwerken werden gesucht!
Wenn Ihre Fähigkeiten diesen Voraussetzungen entsprechen und Sie ausserdem einen Ideenreichtum und konstruktives Können besitzen; wenn Sie dazu imstande sind, eine Konstruktion gründlich auszuarbeiten und dabei so fleissig, dass Sie die Pläne innehalten können, an deren Aufstellung und Ausarbeitung Sie mitbeteiligt sein werden, dann können wir Sie gebrauchen!
Wir bieten Ihnen äusserst interessante Aufgaben, angenehme Arbeitsverhältnisse und ein gutes Einkommen.
Bitte, senden Sie Ihre schriftlichen Bewerbungen—unter Hinzufügung der nötigen Auskünfte—an das elektroakustische Laboratorium von

A/S BANG & OLUFSEN
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A number of suitably qualified candidates will be required for training, leading to permanent and pensionable employment. (Normally at Cheltenham but with opportunities for service abroad or appointment to other U.K. stations.)

Applicants must be 19 or over and be familiar with the use of Test Gear and have had Radio/Electronic workshop experience. They must offer at least "O" level G.C.E. passes in English Language, Maths, and/or Physics, or hold the City and Guilds Telecommunications Technician Intermediate Certificate or equivalent technical qualifications.

Pay according to age, e.g., at 19, £722; at 25, £929 (highest pay on entry) rising by four increments to £1,067.

Prospects of promotion to grades in salary range £997-£1,634.

Annual leave allowance of 3 weeks, 3 days, rising to 4 weeks 2 days.

Normal Civil Service sick leave regulations.

Apply:
Recruitment Officer (RT/3),
Government Communication
Headquarters,
Oakley, Priors Road, Cheltenham.

HYDRAULICS RESEARCH STATION.
WALLINGFORD, Berks.
ASSISTANT Experimental Officer (preferably aged 22-25) for design, development and construction of instruments, and control systems for hydraulic models. Work mainly electronic but partly mechanical. Qualifications: Degree, Dip. Tech., H.N.C., or equivalent in appropriate subject. Under 22, minimum qualification is 2 G.C.E. "A" levels in Science and/or Maths. subjects. Experience of circuit design and construction of d.c. and I.F. amplifiers, control and switching circuits desirable. Salary: A.E.O. £549 (at 18)—£776 (at 22)—£983 (at 26 or over)—£1,201.—Housing available for married staff. Application forms from the Director at the above address quoting E/AL/023. [1196

BRADFORD INSTITUTE OF TECHNOLOGY.
(PROPOSED University of Bradford)
DEPARTMENT of Chemical Engineering.
APPLICATIONS are invited for the post of Senior Technician to carry out duties in connection with instrumentation and electronics; candidates should have experience in the field of industrial instrumentation and an appropriate qualification at H.N.C. level; Salary according to qualification and experience within range £810-£1,010 per annum.
APPLICATION forms from Secretary, Bradford Institute of Technology, Bradford, 7. [1188

THE Diplomatic Wireless Service has vacancies for experienced Radio Operator Technicians between the ages of 20-45 years.
QUALIFICATIONS:—
ABILITY to send and receive morse at 25 w.p.m. and to maintain basic W/T equipment. Touch-typing an advantage. Conditions of service include unreserved acceptance of overseas service and shift duties. Families normally accompany husbands to overseas posts where accommodation is provided.
STARTING pay at age 25 and over £921 rising to £1,246 (National rate) per annum. Adequate allowances are paid whilst overseas.
ALL first appointments are on a temporary basis and candidates must be prepared to undergo a medical examination.
CANDIDATES and both their parents must have been British subjects at all times since birth.
WRITE, giving age, qualifications and experience and quoting O.T. 65, to the Personnel Officer, Diplomatic Wireless Service, Hanslope Park, Wolverton, Bucks. [1200

DO YOU WANT TO WORK ON A COMPUTER IN THE LONDON AREA?

An increasing number of computers are kept working for customers in the London area by English Electric-Leo-Marconi. Site Computer Engineers are needed to provide this service at such installations. Shift work is necessary in most cases, but there are compensations.

Keenness and a sense of responsibility are the essential qualifications, but quickness of thought and electronic background are also necessary. Experience with pulse circuitry and transistors would be an advantage.

As well as openings for engineers there are opportunities for mechanics who have had experience on teleprinter equipment or similar perhaps in the Armed Services.

If you think that you match up with these requirements and you want to make contact with us please ring Mr. C. G. Ashby, on ELGar 2894 any working day between 2 p.m. and 5 p.m. or write to:

The Technical Staff Officer, Dept. WW/L.41, English Electric-Leo-Marconi Computers Ltd., Kidsgrove, Stoke-on-Trent.

ENGLISH ELECTRIC LEO MARCONI

TELEMETRY/TELECOMMUNICATIONS ENGINEER

BP requires an engineer qualified to H.N.C. standard to operate and maintain a new telecommunications/telemetry network in the ARABIAN GULF. Applicants, aged 24-30, should have experience with modern medium power MF, HF and VHF single and multi-channel radio, radar, small auto telephone exchanges and must have experience of digital data telemetry and control systems using transistors and other solid state devices. The position is "single status" with home leave every 4 months, and is for an initial contract of 2 years. Conditions of service are excellent. Please send full details of qualifications and experience quoting reference F.631, to Box 3599 c/o Hanway House, Clark's Place, London, E.C.2.

ITA Engineering Staff

The INDEPENDENT TELEVISION AUTHORITY has vacancies for ENGINEERING STAFF at its Transmitting Stations.

The work on the Stations consists of the operation and maintenance of television transmitters and ancillary equipment. This calls for a high degree of skill and knowledge of electronics, television techniques and high frequency engineering; these vacancies are for young men with good basic knowledge who can be given appropriate training. A Higher National Certificate in Electrical Engineering or similar qualification is required.

Conditions of service are excellent and include a contributory pension scheme. Shift working is involved to cover the period from 8 a.m. to midnight.

Starting salaries, depending on qualifications and experience, will be within the scale £875 to £1,145. Applications in writing, stating age and details of experience and qualifications and quoting Reference Number WW/583 should be addressed to the:

PERSONNEL OFFICER
INDEPENDENT TELEVISION AUTHORITY
70 BROMPTON ROAD, LONDON, S.W.3

EKCO ELECTRONICS, Ltd., Southend-on-Sea, have vacancies for interesting work on airborne radar equipment for (a) Defect Investigation Engineer and (b) Assistant to Training Engineer (training customers engineers in maintenance practice).

KNOWLEDGE of radar techniques essential. Ex R.A.F. personnel with technical experience of air radar should suit these posts. Salary commensurate with experience and qualifications. Write stating full details to Personnel Manager. [1193

C.O.I. The CENTRAL OFFICE OF INFORMATION requires a qualified and experienced **TELECOMMUNICATIONS OFFICER** (Unestablished) to oversee the world-wide network of communications used by the C.O.I. for the purpose of supplying press material to the Information Officers of H.M. Embassies and High Commissions, and to be responsible for planning future developments. The successful applicant must be familiar with the latest technical developments. Experience in running a communications system overseas and in dealing with Government Departments will be an advantage. Salary £1,777 to £1,952 per annum.

Please send postcard for application form to **Manager (PE.2377/EW), Ministry of Labour, Professional & Executive Register, Atlantic House, Farringdon St., London, E.C.4.** Closing date for completed forms 14th May, 1965.

HOME OFFICE CENTRAL COMMUNICATIONS ESTABLISHMENT AT PRESENT AT STANMORE, MIDDLESEX, BUT MOVING TO HARROW, MIDDLESEX IN AUTUMN 1965.

Wireless Technicians
required for varied and interesting work on all aspects of the provision and maintenance of a wide range of v.h.f. and u.h.f. communications systems for Police, Fire, and Civil Defence Services. Some posts involve some travelling and short periods of field work. A few posts may be available also at Regional Wireless Depots throughout England and Wales.

Salary £792 at age 21, rising to £929 at age 25 (this being the highest rate payable on entry) increasing to a maximum of £1,067 by annual increments. In addition an outer London weighting allowance, at present amounting to £45 to £50 per annum, is payable to Stanmore staff. Annual leave allowance is 18 days rising to 22 days after 10 years service.

Applicants, who must be natural-born British subjects between 21 and 40, should have a general education to "O" level standard and a sound and up-to-date knowledge of radio theory and practice, preferably supported by relevant City and Guilds Telecommunications Technicians, or Ordinary National, Certificates.

All appointments will be unestablished in the first instance but there are good prospects of establishment and promotion.

Opportunities for further technical education will normally be available.

Further particulars and application forms are obtainable from Communications Branch, Home Office, Whitehall, London, S.W.1.

Prospective applicants who would like to visit the Central Communications Establishment for an informal preliminary discussion are invited to telephone STOnegrove 5691, Extension 20, for an appointment.

MARINE SERVICE TECHNICIANS TO WORK IN CANADA

Immediate openings are available with the Canadian Marconi Company in Quebec, Ontario and the Maritime Provinces.

Salaries would range from $350.00 to $450.00 monthly depending on the qualifications of the individual candidate.

Applicants must be experienced with marine radio and radar equipment. 2nd PMG or amateur certificate as well as some sea-going experience could be useful.

Those applying must be capable of working independently with a minimum of supervision. Candidates familiar with the following types of equipment will be given first consideration: Radar; H/F, W/T and R/T; VHF, FM and R/T; M.F.D.F. and Echo Sounders.

Please write with full details, quoting reference WW2990F, to:
Technical Staff Officer, English Electric House, Strand, London, W.C.2

CMC CANADIAN MARCONI

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- SINGLE sideband equipment.
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- HI-FI reproduction equipment.

WE require trained personnel for production testing and fault finding of modern equipment.
WE have limited vacancies for more senior and experienced men with drive, who can lead small teams engaged on this work.
WE have also limited vacancies for persons of less experience who can be trained for such work.
APPLY to: The Personnel Manager. [131

EXPERIENCED prototype wiremen and testers required by fastest-growing, small electronics company in the country; good rates and excellent prospects as we expand; variety of products; testers required for transistorized equipment.—Electronic Laboratories (Hendon), Ltd., Spalding Hall, Victoria Rd., London, N.W.4. Tel. SUNnyhill 4128. [1191

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SENIOR Technician, Department of Zoology.
AN Electronics Technician is required in the Department of Zoology to be responsible for the design, construction and maintenance of electronic apparatus used in physiological research and teaching.
POSSESSION of the National Certificate in Electrical Engineering or equivalent would be an advantage. Pension scheme; five-day week; four/five weeks' annual leave.
APPOINTMENT according to ability, etc., on scale £840 to £1,040 p.a., plus London Weighting up to £45 and possible £30 or £50 qualification supplement.
LETTERS only to the Registrar (ZST) stating age and giving full details of experience and present work. [1198

TV service engineer required, good pay 5-day week. 3 weeks' holiday with pay.—Singer's Radio, Ltd., 261, Harrow Rd., London, W.2. Cunningham 0707. [138

AN INVITATION TO ALL QUALIFIED ENGINEERS

Professional Electronic Design Engineers with specialist experience in any aspect of Electronic Technology are invited to apply for registration with a New Company of Consultant Engineers.

If you have expert knowledge in your field and can undertake design, Part Time or in your Spare Time on a Fee basis, please write or phone:

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Permanent appointment in an expanding company.

40-hour week.

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DEPARTMENT of Electrical and Electronic Engineering.
ELECTRONIC Technicians.
APPLICATIONS are invited for the following laboratory posts:
CHIEF Technician—commencing salary £1,085 per annum, rising by annual increments to a maximum of £1,255 per annum.
SENIOR Technician—salary scale £835 per annum, rising by annual increments to a maximum of £1,035 (unqualified) or £1,105 (qualified) per annum. The commencing salary may be fixed above the minimum in certain circumstances.
JUNIOR Technician—commencing salary on the scale £300 to £695 according to age and qualifications.
EXPERIENCE of research, development and testing or servicing of electronic equipment is necessary for the senior posts.
APPLICATIONS must be made in writing stating clearly the appointment which is sought. Candidates should give details of age, experience and qualifications and address their applications to.—The Secretary, Borough Polytechnic, Borough Rd., London, S.E.1. [1196

ELECTRONIC Service Engineers required to service and install Airborne Navigational Equipment at London Airport, Home Counties and Overseas.—Apply: The Decca Navigator Co., Ltd., Spur Rd., Feltham, Middlesex. Tel. Feltham 4898. [1190

SERVICE engineer required for 16mm sound film projectors; knowledge of amplifiers essential; must be driver.—Burgess Lane & Co., Ltd., Thornton Works, Thornton Ave., Chiswick. Chi. 5752. [1132

MINISTRY OF DEFENCE (Air Force Department)

have vacancies for CIVILIAN RADIO TECHNICIANS at RAF Sealand, Cheshire, and other RAF Stations throughout the United Kingdom for the servicing, repair, modification and testing of air and ground radio and radar equipment. Commencing salary according to age is £722 to £929 p.a., max. salary £1067 p.a. Houses may be available for renting at West Kirby some 15 miles from Sealand.

Apply to Ministry of Defence (CE3b(Air)), Sentinel House, Southampton Row, W.C.1 or to any Employment Exchange.

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At our new Farnborough factory we are selecting Prototype Wiremen for posts in our Data Handling, Data Logging and Analogue Computer Systems Assembly areas.

Applications are invited from experienced wiremen able to work from circuit diagrams and engineers' sketches.

Salaries are progressive and will commence in the range of £15 to £18.15s. per week according to experience.

We work a 5 day, 40 hour week. Membership of our non-contributory pension fund and sick pay scheme is automatic.

Please apply: Miss C. J. Read, Personnel Officer,

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ELECTRONIC TESTERS and SERVICE ENGINEERS REQUIRED

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Five Day Week.
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Inspector
Telecommunications/Electronics

The Burmah Oil Company Ltd. wish to employ on a temporary basis for a period of approximately one year, an Inspector with experience of inspection of radio and electronic equipment. The first requirement is that the candidate should have a good background of radio electronics and a thorough knowledge of inspection work. It would be an advantage if the candidate also had a knowledge of test techniques and procedures. We envisage that a retired man with a suitable background, and prepared to travel in U.K. might be suitable. Salary by negotiation. Please apply giving full details to the **Staff Manager, The Burmah Oil Co. Ltd., Britannic House, Finsbury Circus, London, E.C.2.**

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We require trained men for production testing, fault finding and inspection of Modern equipment.

★ **SINGLE sideband equipment**
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★ **ELECTRONIC telephone exchanges**

We have limited vacancies for more senior and experienced technicians with drive, who can lead small teams. There are also vacancies for men with less experience who can be trained for such work.

Apply : **The Personnel Manager, Cambridge Works Limited, Haig Road, Cambridge.**

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Due to continued expansion NCR require additional ELECTRONIC and ELECTRO-MECHANICAL ENGINEERS for Computer Maintenance. Posts are available for men wishing to become Site Engineers.
Training Courses are arranged for suitably qualified men. H.N.C. Electronics, City & Guilds Final or equivalent standard required. Men from Forces with radar experience welcome. Knowledge of electronic or electro-mechanical equipment necessary.

Please write for Application Form to:—

The Personnel Officer,
The National Cash Register Co. Ltd.,
206/216, Marylebone Road, London, N.W.1.

ELECTRONIC TESTERS

A number of vacancies exist for both trainee and experienced testers at the Test Division, Chelmsford. These are staff appointments enjoying a 37½-hour five day week and leading to good careers in the testing of all kinds of modern complex electronic equipment.

Applicants should have some knowledge of, or should wish to gain experience in, the fields of Television, Radar, Point to Point Communications or Navigational Aids.

Marconi

Write giving full details of qualifications and experience to The Marconi Company Limited, Technical Staff Officer, Group Personnel Services, English Electric House, Strand, London WC2, quoting reference WW/2504/C.

The Marconi Company Limited, Chelmsford, Essex

GRAMPIAN REPRODUCERS, Ltd., require Senior Test Engineer to take charge of test department; must be fully conversant with sound amplification systems.—Apply Dept. R.B., Hanworth Trading Estate, Feltham, Middlesex. [1115

RADIO Mechanics required for workshop overhaul of aircraft radio/electronic equipment, applicants, preferably with experience of aircraft equipment overhaul or industrial radio testing and fault finding; generous rates of pay, pension scheme, sick pay and holidays.—Apply: Canford Engineers, Ltd., Stansted Airport, Stansted, Essex. [1192

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VACANCIES IN THE COMPOSITE SIGNALS ORGANISATION

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RADIO OPERATORS (Male)

Candidates should have a minimum of two years' practical Radio Operating experience.

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Stonegrove 7624

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N. Finchley, N.12

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APPLICATIONS are invited for the following posts:—PHYSICIST or engineer with experience in electronic circuit design. Experience in clinical application not necessary. Grading equivalent to that of university lecturer on scale £1,400×£85—£2,165, subject to review to £2,505+London Allowance.
TECHNICIAN to help in development and maintenance of electronic apparatus. Salary scale £668-£833 per annum plus London Weighting.
THE work of the department is concerned with the application of electronic techniques to medical diagnosis and therapy. The research programme includes e.g. EEG data analysis, radio pill telemetry and the measurement of blood flow. Apply, naming two referees, to the Clerk to the Governors within 21 days, quoting PT/444. [1198

QUEEN MARY COLLEGE (University of London), Mile End Rd., E.1.
NUCLEAR Engineering Department. Senior Technician. A SENIOR Technician is required to help in the development of electronic equipment for a variety of functions within the Nuclear Engineering Department. He will also be required to assist in the maintenance of existing electronic equipment.
THE work of the department includes reactor technology, precision mechanical engineering and all aspects of nuclear and health physics instrumentation.
EXPERIENCE in electronics is an essential requirement. Pension Scheme; five-day week; four/five weeks' annual leave.
APPOINTMENT according to ability, etc., on scale £840 to £1,040 p.a., plus London Weighting up to £45 and possible £30 or £50 qualification supplement.
LETTERS only to the Registrar (NST) stating age and giving full details of experience and present work. [1197

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ARTICLES FOR SALE

FERROGRAPH 5/AN (March 1964, £62, no offers (London).—Box WW 110, Wireless World.

LAFAYETTE International Tape; example: 7in. 2,400ft. polyester, 22/6; p. & p. 2/-; wide range; s.a.e. list.—Leda Tapes, 27, Baker St., W.1. [72

GOVERNMENT Surplus Electrical and Radio equipment, our new catalogue No. 16 ready now, 2/6 post free, cost refunded on purchase of goods over £2.—Arthur Sallis Radio Control, Ltd., 93, North Rd., Brighton. [200

PLATING units.—New 6v 50amp d.c. output, fitted meters, fuses, variable control, neat Unit for Lab. use. 240v a.c. input, £38; Auto-transformers 240/110v 500watt fully shrouded, 45/-; transformers, output EL34 push-pull to 3 ohms, 37/6.—Malden Transformer Supplies, 134, London Rd., Kingston upon Thames. Kin. 7534. [90

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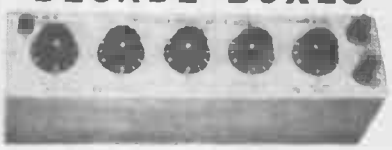

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UNIVERSITY OF NOTTINGHAM

Faculty of Applied Science
Department of Electrical and Electronic Engineering

EXPERIMENTAL OFFICER

Applications are invited for the above appointment to commence on 1st October, 1965. Candidates should have a good knowledge and practical experience of basic electronic circuit techiques using both vacuum-tube and solid-state devices; they will normally be expected to have H.N.C. or equivalent qualification.

The commencing salary will be within the range £880×£40 to £1,200.

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The London Borough of
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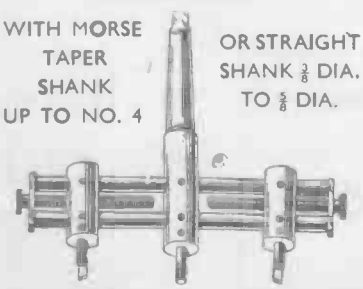

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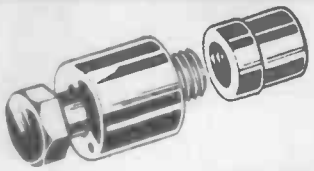

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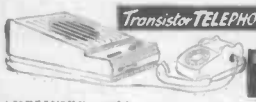

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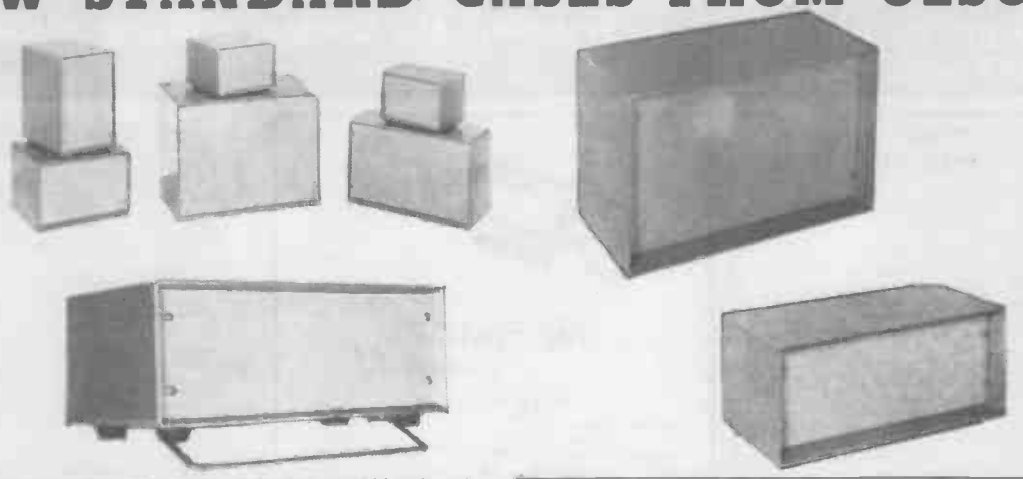

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3½	7,000	3	9/6
3½	9,500	3	10/6
3½	9,500	8	10/6
3½	7,000	35	8/6
3½	9,500	50	10/6
4	9,500	25	11/6
4	9,000	50	11/6
4	9,500	15	12/-
4	7,500	5	9/6
4	7,000	25	11/6
4	6,000	35	10/6
4	7,000	35	11/-
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5 × 3	9,000	35	12/-
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5 × 3	9,000	4	8/6
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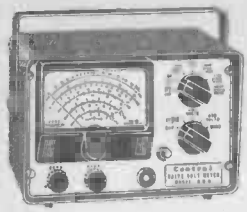

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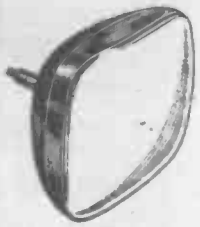

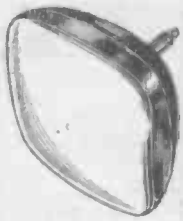

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See also Page 106

INDEX TO ADVERTISERS

Appointments Vacant Advertisements appear on pages 135 to 145

	PAGE
Acoustical Mfg. Co., Ltd.	19
Adcola Products, Ltd.	56
Advance Electronics, Ltd.	34, 67
Advance Relays, Ltd.	34, 67
A.E.I. Cables, Ltd.	134
Airmec, Ltd.	81
Airmed, Ltd.	44
Akurate, Eng. Co., Ltd.	146
Amalgamated Wireless (Australasia), Ltd.	55
Anders Electronics, Ltd.	21, 23
A.N.T.E.X., Ltd.	2
A.P.T. Electronic Industries, Ltd.	32
Armstrong Audio, Ltd.	101
Audio Services, Ltd	63
Avo, Ltd.	1, 3
Batey, W., & Son, Ltd.	65
Belling & Lee, Ltd.	84
Bentley Acoustic Corpn., Ltd.	120
Berry's Radio	134
Bradley, G. & E., Ltd.	41
Brenell Engineering Co., Ltd.	4
Britain, Chas. (Radio), Ltd.	103
British Communications Corpn., Ltd.	53
British Institute of Engineering Technology	46
British National Radio School	150
Broadfields	144
B.S. Radio & Electrical Store	116
Bulgin, A. F., & Co., Ltd.	Edit. 257
Bullers, Ltd.	95
C. & N. (Electrical), Ltd.	42
Cannon Electric, Ltd.	78
Carr Fastener Co., Ltd.	95
Celestion, Ltd.	86
Cesar Products, Ltd.	151
Chambers College	130
Clark, A. N. (Engineers), Ltd.	36
Clyne Radio, Ltd.	126, 127
Creators, Ltd.	70
C.R.E.I. (London)	35
Cursons, B. W.	148
Daly Condensers, Ltd.	134
Dawe Instruments, Ltd.	96
Daystrom, Ltd.	8, 9, 10, 11
Dependable Radio Supplies	150
Drake Transformers, Ltd.	17
E.K. Electronics (I.A.), Ltd.	46
Electro-Winds, Ltd.	96
Electronics (Croydon), Ltd.	128, 129
Electrosil, Ltd.	26
English Electric Valve Co., Ltd.	18
Epsylon Industries, Ltd.	46
Erie Resistor, Ltd.	33
ETA Tool Co., Ltd.	100
Fane Acoustics, Ltd.	50
Ferranti, Ltd.	Cover ii, 51, 90
Ferrograph Co., Ltd.	30
F.I.A.R.	54
Finnegan Speciality Paints, Ltd.	146
F.N.I.E.	63
Fringevision, Ltd.	94
Garrard Eng., Ltd.	14
Gee Bros. (Radio), Ltd.	115
Gladstone Radio	115
Glaser, L., & Co., Ltd.	145
Goldring Mfg. Co. (G.B.), Ltd.	93
Goodmans Industries, Ltd.	37, 48
Goodwin, C. C. (Sales), Ltd.	100
Grampian Reproducers, Ltd.	66
Greenwood, W. Electronic, Ltd.	13
Hall Electric, Ltd.	12
Harmsworth, Townley & Co.	42
Harris Electronics (London), Ltd.	149
Harris, P.	149
Harverson Surplus Co., Ltd.	114
Hengstler, J., Co., Ltd.	92
Henry's (Radio), Ltd.	113
Her Majesty's Stationery Office	130
High-Fidelity Centre	70
Howell's Radio, Ltd.	97
H.P. Radio Services, Ltd.	62
Hunt, A. H. (Capacitors), Ltd.	31
Iliffe Books, Ltd.	125, 146, 152
I.M.O. (Electronics), Ltd.	106
Impex Electrical, Ltd.	46
"Industrial Electronics"	112
Industrial Exhibitions	40
Insulators, Ltd.	20
International Correspondence Schools	66
International Rectifiers, Ltd.	28
Interplas	27
I.T.W., Ltd.	97
J.T. Supply	150
K.E.F. Electronics	94
Keyswitch Relays, Ltd.	7
Labgear, Ltd.	57
Lasky's Radio, Ltd.	122, 123, 124, 125
Lawson Tubes	151
Leak, H. J., & Co., Ltd.	85
Ledon Instruments, Ltd.	115
Leevers-Rich Equipment, Ltd.	62
Levell Electronics, Ltd.	29
Lewis Radio Co.	114
Lexor Electronics, Ltd.	46
Light Soldering Developments, Ltd.	66
Lind-Air, Ltd.	102
Linear Products, Ltd.	60
Linstead Electronics, Ltd.	54
Lionmount & Co., Ltd.	145
London Central Radio Stores	151
Lyons, Claude, Ltd.	16, 76
M.A.C., Ltd.	116
Mail Orders	147
Malvyn Engineering Works	146
Marconi Company, Ltd.	77, 80
Marconi Instruments, Ltd.	47, 49
McMurdo Instrument Co., Ltd.	45
Mills, W.	119
Minimitter (1964), Ltd.	52
Modern Book Co.	149
Moss Watson Co.	150
M.R. Supplies, Ltd.	44
Mullard, Ltd.	74
Multicore Solders, Ltd.	134, Cover iv
Multitone Electric Co., Ltd.	43
Newmarket Transistors, Ltd.	24
Nicholls, E. R.	152
Nombrex, Ltd.	96
Olson Electronic, Ltd.	148
Orchard & Ind., Ltd.	68
Oxley Developments Co., Ltd.	44
Palmer, G. A. S., Ltd.	39
P. & M. Services	144
Partridge Transformers, Ltd.	94
P.C. Radio, Ltd.	111
Peto-Scott Electrical Instruments, Ltd.	64
Philips N.V.	82
Picard, Henri & Frere, Ltd.	60
Pinnacle Electronics, Ltd.	15
Post Radio Supplies	151
Premier Radio Co.	126, 127
Proops Bros., Ltd.	117
Pye Telecommunications, Ltd.	58, 59
Quarndon Electronics	130
Quartz Crystal Co., Ltd.	134
Raaco, Ltd.	62
Racal Instruments, Ltd.	61
Radford Electronics, Ltd.	50
Radio & T.V. Components (Acton), Ltd.	118
Radio Clearance, Ltd.	148
Radio Component Specialists	98
Radio Exchange Co., The	116
Radiospares, Ltd.	146
Radiostructor	97
Raife, P. F.	131
R. & R. Radio	151
Reproducers & Amplifiers, Ltd.	22
Reslosound, Ltd.	91
Rollet, H., & Co., Ltd.	150
R.S.C. (Manchester), Ltd.	104, 105
Salford Elec. Inst. Co. Ltd.	68
Samsons (Electronics), Ltd.	107
"Science Journal"	121
Scientifica	65
Scientific Products	149
Service Trading Co.	98, 99
Shure Electronics, Ltd.	25
Sifam Electrical Instrument Co., Ltd.	70
Sinclair Radionics, Ltd.	87, 88, 89
S.M.E., Ltd.	36
Smith, G. W. (Radio), Ltd.	108, 109
Smith, H. L., Co., Ltd.	38
Smith, John, Ltd.	56
Sotonian Trading Co	131
Sound Coverage, Ltd.	150
Southern Radio Supply, Ltd.	145
Sovirel	71
Sowter, E. A.	144
Specialist Switches, Ltd	68
S.P.S. International, Ltd.	92
Stamford, A. L., Ltd.	150
Standard Telephones & Cables, Ltd.	Cover iii
Stern-Clyne, Ltd.	126, 127
Stratton & Co., Ltd.	56
Sutton Electronics	151
Tannoy, Ltd.	150
Tape Recording Magazine	144
Technical Trading Co.	144
Telegraph Condenser Co., Ltd.	75
Telequipment, Ltd.	72
Thompson, A. J.	130
Thorn A.E.I. Radio Valves & Tubes, Ltd.	79
Tricitair	130
T.R.S. Radio	120
Universal Book Co.	150
Vacwell Sng. Co., Ltd.	69
Valradio, Ltd.	52, 60
Vitality Bulbs, Ltd.	96
Vortexion, Ltd.	83
Watts, Cecil E., Ltd.	148
Waveforms, Ltd.	144
Webber R. A., Ltd.	100
Wells, J.	144
West Instruments, Ltd.	90
Weymouth Radio Mfg. Co., Ltd., The	38
Wharfedale Wireless Works, Ltd.	52, 64, 65
Whiteley Electrical Radio Co., Ltd.	6
White, S. S. Dental Mfg. Co., Ltd.	5
Wilkinson, L. (Croydon), Ltd.	100
Wirecomp Electronics	110
Z. & I. Aero Services, Ltd.	132, 133

Printed in Great Britain for the Publishers, ILIFFE ELECTRICAL PUBLICATIONS LTD., Dorset House, Stamford St., London, S.E.1, by CORNWALL PRESS LTD., Paris Garden, London, S.E.1. *Wireless World* can be obtained abroad from the following: AUSTRALIA and NEW ZEALAND: Gordon & Gotch, Ltd. INDIA: A. H. Wheeler & Co. CANADA: The Wm. Dawson Subscription Service, Ltd.; Gordon & Gotch, Ltd. SOUTH AFRICA: Central News Agency, Ltd.; William Dawson & Sons (S.A.), Ltd. UNITED STATES: Eastern News Co., 306 West 11th Street, New York 14.

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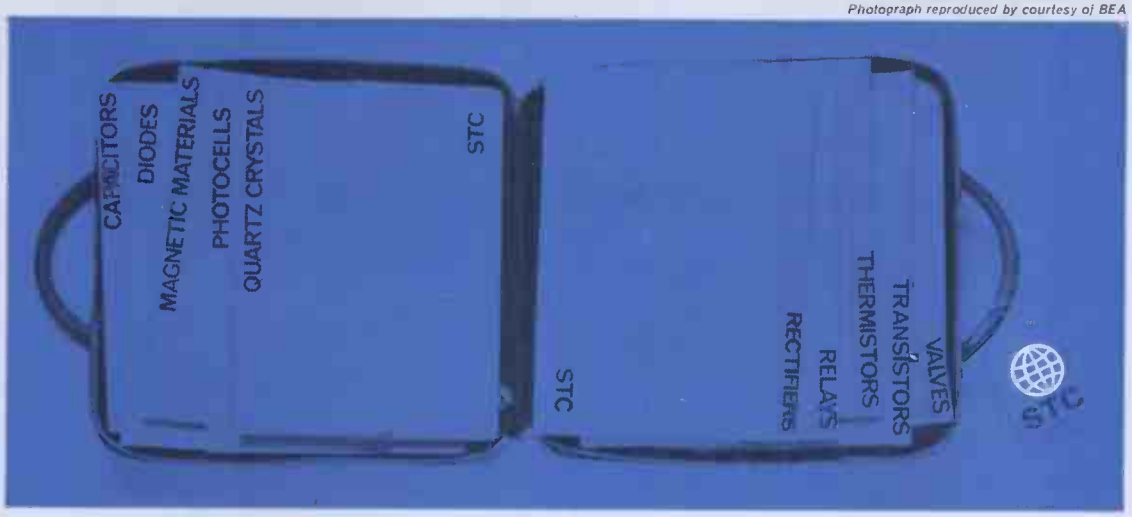

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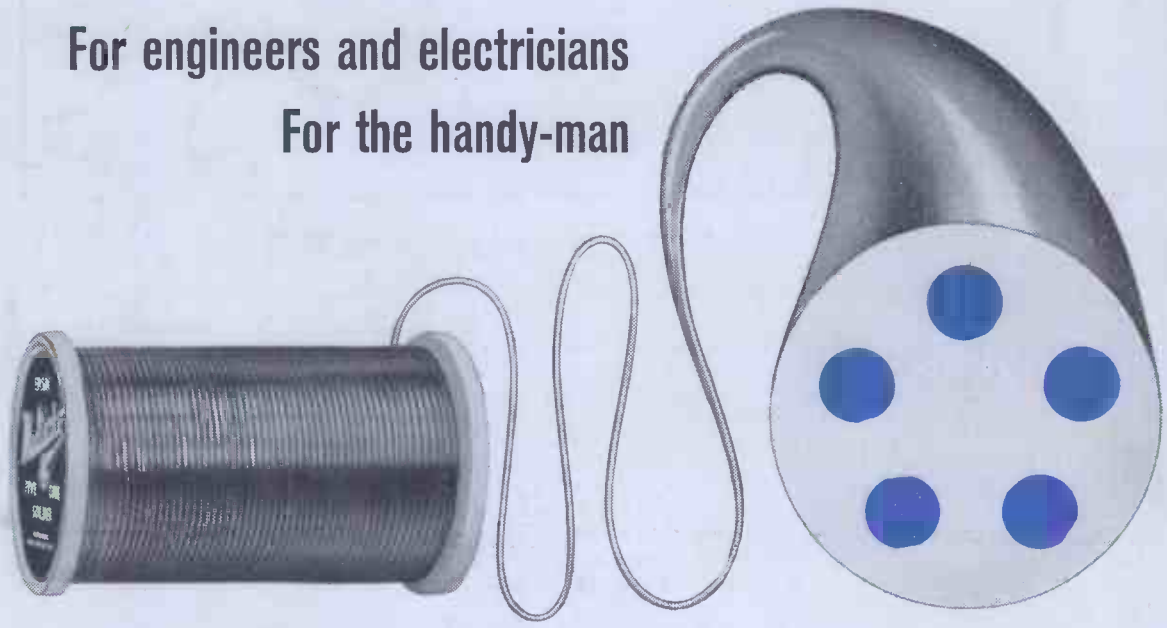

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